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JOHN F. KELLY, EDITOR

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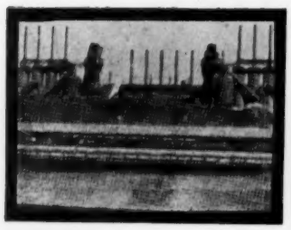
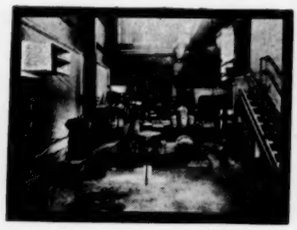
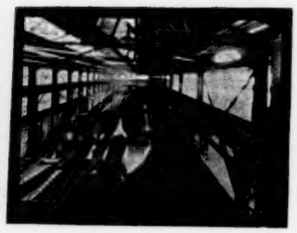

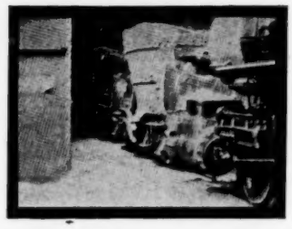

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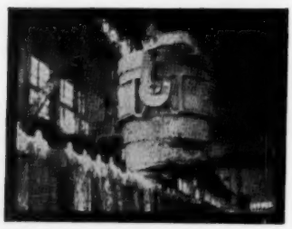

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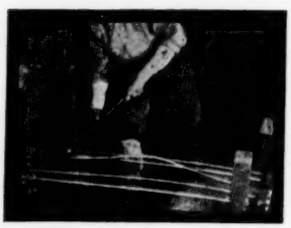

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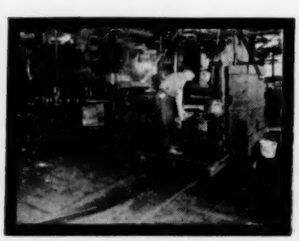
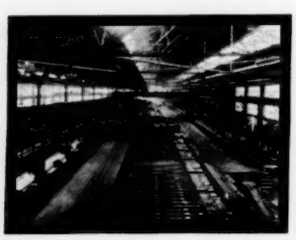
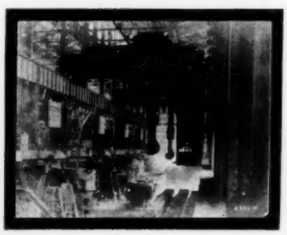

EDITORIALS

NEW USES FOR STEEL . . .

Forged steel housings, in place of castings, on a new four-high cold mill built for the Sheet and Tin Plate Industry, excited the interest and favorable comment of over 500 steel mill executives who attended the A. I. & S. E. E. Inspection Trip held in connection with our campaign for "New Uses for Steel" on May 20th at the E. W. Bliss Company, Salem, Ohio. It is predicted that the general adoption of this type of housing to rolling mills will mean a market for 150,000 tons of Steel a year. However, rolling mills are only one part of the machinery field. The universal acceptance of fabricated rolled Steel in the design and construction of all machinery offers an outlet for more huge tonnages. This is clearly shown in a paper by Mr. H. G. Marsh of the Carnegie Steel Company, presented before the American Iron and Steel Institute and abstracted in this current issue of the Iron and Steel Engineer. Quoting from the conclusion of Mr. Marsh's paper, he states that "From estimates made by those who are in close touch with these latest developments of fabricated rolled steel in connection with machine construction, they offer a potential increase of several million tons to the production of our plate and structural mills."

To aid in developing this attractive market for fabricated rolled steel, the Association of Iron and Steel Electrical Engineers, as sponsors of the campaign for "New Uses for Steel" suggest that to give this development the proper start the impetus should come from within; by which is meant the Steel Industry itself should make every effort to absorb as much of its own product as possible on all new machinery and to make extensive use of it in its maintenance work. By submitting fabricated rolled Steel to the many diversified and arduous conditions met with in the manufacture of Steel, a testing laboratory would be set up through which many of its advantages and disadvantages would be brought to light. The results of these laboratory tests on fabricated rolled Steel would provide many of the selling points necessary before its general acceptance by the designers and manufacturers of machinery.

A. I. & S. E. E. CONVENTION AND EXPOSITION . . .

With favorable signs pointing to nearly normal operating conditions in the Steel Industry by Fall, the Board of Directors of the Association of Iron & Steel Electrical Engineers are formulating the plans for its Twenty-ninth Convention and Exposition, which will be held October 17th, 18th and 19th at the William Penn Hotel, Pittsburgh, Pa.

These plans, which your Board of Directors are shaping, promise a Convention and Exposition of undeniable merit. Papers and discussions are being arranged for the Electrical, Mechanical, Lubrication, Combustion and Safety Engineering Divisions, which will in a thorough manner survey the contemporary and future engineering problems of the Industry. The Iron and Steel Exposition, held in conjunction with the Convention, will house all the steel mill equipment manufacturers' latest engineering developments. The awarding of prizes for the best suggestions contributed in connection with our "New Uses for Steel" campaign will be one of the Convention highlights.

You, your friends and associates are cordially invited and will be most welcome at our technical sessions, where the latest developments in steel mill apparatus and practices will be described and discussed, as well as at our Exposition, where this new equipment will be on display. Arrange your plans now to attend.

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Air Conditioning Equipment for Rolling Mill Motors

By C. J. SMITH
Elec. Engr., Illinois Steel Co., S. Chicago, Ill.

Presented before the Chicago District Section of the A. I. & S. E. E., March, 1933.

The following discussion is a review of developments in the use of air conditioning equipment for rolling mill motors as experienced at South Works of the Illinois Steel Co. Roughing Mill motors of the direct current reversing type operate a large percentage of the time at from zero to base or full voltage full field speeds and do not afford effective self ventilation. For this reason the ratings of such machines are specified contingent upon the circulation of definite amounts of ventilating air. Adjustable speed direct current motors and continuously running alternating current motors are usually considered as self ventilating and are rated without regard to a supply of ventilating air.

In many cases however, local conditions warrant and even necessitate the circulation of air to such machines. For example, space limitations governing the size of enclosing structures or motor rooms, may result in a building too small to allow the removal of the heat, produced by internal motor losses, as fast as generated. Ultimate temperatures may then be encountered which will rapidly deteriorate the insulation of the windings and render successful operation impossible. In continuous mills, where there is a concentration of motors and motor generator sets of very large aggregate capacity in a relatively small space, such a condition may obtain, even though there are no space limitations except those dictated by a reasonable height of crane and roof and a reasonable amount of floor space for dismantling of equipment in case of necessary repairs. Likewise the presence of acid fumes, soot, scale, etc., may make necessary a supply of clean air to the motors to prevent commutation difficulties or insulation failures.

The first development of air conditioning equipment at South Works was in connection with the 4000 HP—600 volt DC reversing motor on the 30" Universal Plate Mill. This motor with its fly-wheel motor-generator set was the first installation of the Ilgner system in the United States, and was put into operation in 1907. Being under the mill crane runway it was necessary to use a low roof construction allowing passage of the crane, over the motor room. The motor room floor is some four feet below the mill floor level. On one side were the slab-heating furnaces, on a second side was the mill, and on a third side was the hot bed. The secondary resistance, used to slow down the wound rotor induction motor driving the flywheel motor generator, and thereby limit power input peaks by causing the flywheel to deliver up a part of its stored energy, consisted of grids cut in and out of circuit by the action of air operated contactors. In later installations liquid slip regulators have been employed, which are equipped with coils circulating cooling water, and thereby removing a large portion of the heat generated by the dissipation of the motor secondary power. However in this case all secondary power was dissipated in resistance grids and appeared as heat in the motor room.

Not withstanding the above described conditions conducive to excessive motor and motor-room temperatures, the equipment was operated successfully for several years without any system of ventilation. This was made possible to a large extent by the liberal design of the machines. A modern motor of the same size and weight would probably be rated at double the horse-power of this early installation. However as the rate of steel production was increased to double that which had been anticipated, the motor room began to reach undesirably high temperatures. A home-made washer consisting of a fan blowing air through water soaked cheese-cloths was installed and used for a time.

In 1918 an additional mill was located adjacent to the Universal Mill, with the reheating furnaces directly opposite the motor room, and made the installation of a ventilating system imperative.

A wet type air conditioning equipment was installed consisting of a fan designed to deliver 20000 C. F. M. of air against a static pressure of 2" of water, and driven by a 30 HP motor. Air is brought in through a series of eliminators to the spray chamber, where it comes in contact with the finely diffused water from the spray nozzles. The air is then drawn out through a second set of eliminators, which remove most of the water and dirt, and delivered to tunnels leading to the pits under the motors and generators in the motor room. In cold weather, a steam coil, located in the path of the incoming air before it reaches the spray chamber, is used to heat the air sufficiently to prevent freezing of the spray water. The air is removed from the motor room by ventilators in the roof. It is not possible in this case to recirculate any part of the ventilating air, since the conditioning equipment is remote from the motor room.

The next installation of air conditioning equipment for roll drive motors was made in 1922 at the 90" and 132" Sheared Plate Mills. These mills were changed over at that time from steam engine to motor drive. Each three high mill was equipped with a 5000 HP—375 RPM wound rotor induction motor slip regulator, reduction gears, and flywheels of 63,500 HP seconds stored energy. Low roof construction was again employed to allow passage of the overhead mill crane. Very limited floor space was available for the electrical equipment. The resulting motor rooms were therefore very small and the circulation of conditioned air was necessary, to insure reasonable motor room temperatures.

One air conditioning equipment was provided for the two motor rooms. Being remotely located no recirculation was possible, and a steam heated tempering coil was installed to prevent freezing of the spray water. A fan of 30,000 CFM capacity against a static pressure of 1 inch, operating at 238 RPM was provided. The driving motor is rated at 20 HP 470 RPM.

Difficulties encountered on the previously described installation, due to the small apertures in the

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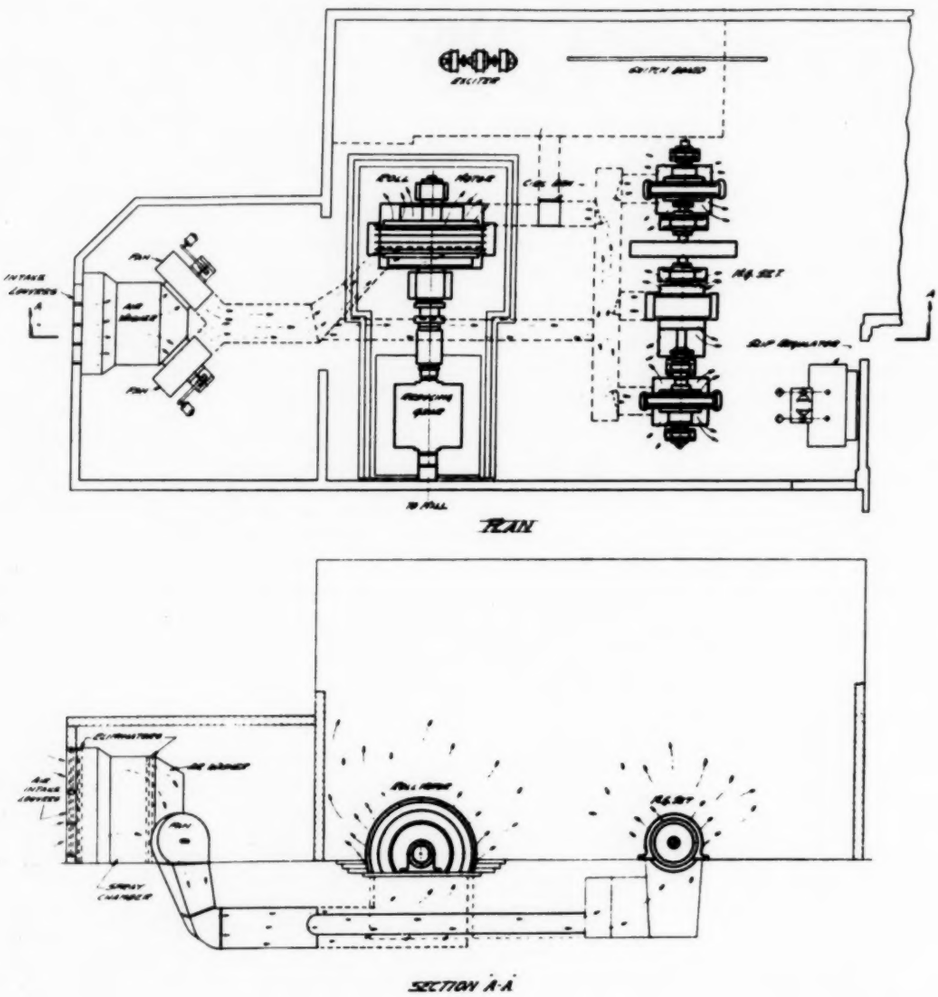


FIG. 1.

spray nozzles becoming frequently clogged by the dirty mill cooling water, led to the trial of an entirely different type of water diffusing equipment. A 5/8" nozzle discharges a full stream of water against the apex of a conical spray head. The spray head is rotated at 1500 RPM by a 3 HP motor. A circle of closely spaced pins, parallel to the axis of rotation, is mounted near the periphery of the rotating spray head. The water travels along the conical surface of the rotating spray head until it meets the pins which act as beaters and diffuse the water into a very satisfactory spray. Eliminators ahead of the spray remove dirt and eliminators after the spray eliminate moisture and entrained dirt. The air is delivered to the motor rooms through an insulated duct at a velocity of 2000 FPM. It is discharged into the motor pits, and out through roof ventilators.

The next installation of motor room air conditioning equipment was in connection with the No. 2-40" Blooming reversing motor drive, installed in 1925. The motor is a 7000 HP 0-50-120 RPM—600 volt DC reversing motor, receiving power from 2-3000 KW generators driven by a 5000 HP, 500 RPM wound rotor induction motor. The total installed capacity of electrical equipment in this motor room is 15,300KW.

The type of air conditioning equipment is similar to that described for the 90-132" Plate Mills. Being located in the same room it is possible to recirculate air in cold weather and reduce steam consumption for preheating of air ahead of the spray chamber.

In 1926 the 12-16" Alloy Bar Mills were constructed. The main motor room contains 8 motors totalling 6500 HP., 600 volt DC motor generator sets of 4000 KW capacity, 250 volt DC motor generator set of 1000 KW capacity and 3 air compressor motors of 300 HP each. The motor room is surrounded on all sides by mill buildings and natural ventilation was not practicable. The roll motors are non-reversing, with a 2-1 speed range by field weakening. These, along with all the other equipment listed, are normally considered self-ventilating, but it was decided to install ventilating equipment to limit the high temperatures anticipated in the motor room. A 1600 HP roll motor and another of 800 HP located in the mill proper, and enclosed in very snug-fitting steel enclosures were arranged to get cooling air from the main motor room system.

The air conditioning system is of the wet type and is non-recirculating. Air is drawn in to the conditioning chamber, through a tempering coil and eliminators to the spray chamber. The two spray

heads are driven by 3 HP 1450 RPM motors. The spray water is recirculated by a similar motor. After passing through additional eliminators, the air is delivered to the fan room. The main blower is of 25000 CFM capacity, at 2" static pressure, operates at 375 RPM and is driven by a 20 HP-720 RPM motor. This air is delivered to a main duct extending the full length of the motor room. Branch ducts deliver air to the roll motor pits.

A second fan of 10000 CFM capacity at 6" static pressure delivers air to the 2-roll motors in the small steel houses in the mill, and to table and hot bed auxiliary motors. This fan operates at 1440 RPM and is driven by a direct connected 25 HP motor.

Three 800 HP motors driving finishing stands on the 12" mill are located on the opposite side of the mill in a small low-roofed building and are supplied by a second air conditioning system. A fan of 10000 CFM capacity at 1" static pressure delivers air to these motors after being conditioned by an equipment similar to that just described for the 12-16" mills. The fan operates at 470 RPM and is driven by a 5 HP motor.

In 1927 the 35" Blooming Mill was changed over from steam engine to motor drive. The motor is a 700 volt DC-6500 HP reversing motor, supplied with power from a motor generator set consisting of a 5000 HP, 375 RPM wound rotor induction motor, a flywheel of 15300 HP seconds stored energy, and 2-3000 KW 700 volt DC generators. The ventilating air requirements for the reversing motor, as specified by the manufacturer were 45000 CFM, at a static pressure of 2.6 inches of water. The air conditioning equipment as installed provides 60000 CFM of air at a static pressure of 3.5 inches. The additional air was used to supply air to the motor generator set. The additional pressure was provided to allow for loss of pressure in the duct system and assure delivery to the motor according to the manufacturers specifications. The fan operates at 355 RPM and is driven by a 75 HP-725 RPM motor.

The normal supply of air used is taken from outside the motor room near the ground level and is sent to a spray chamber through a set of eliminators, louvers and another set of eliminators. In the chamber, a mist is formed by two spray heads moving against streams of water which are forced out through as many nozzles by one of two pumps taking water from a pan forming the bottom of the chamber. The water used is recirculated with make-up provided from the plant system by a float valve. One, or both, of two fans draws the air over this

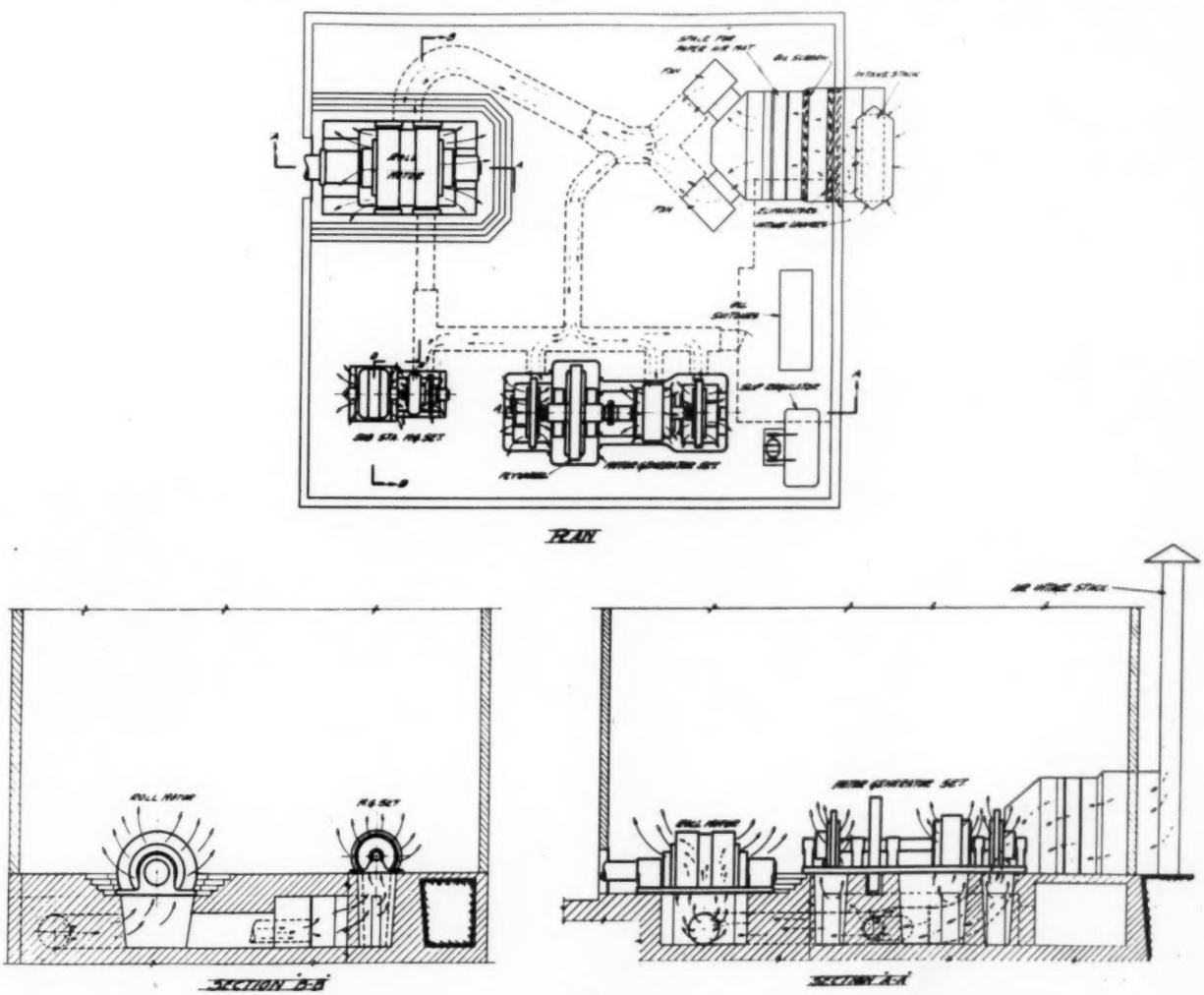


FIG. 2.

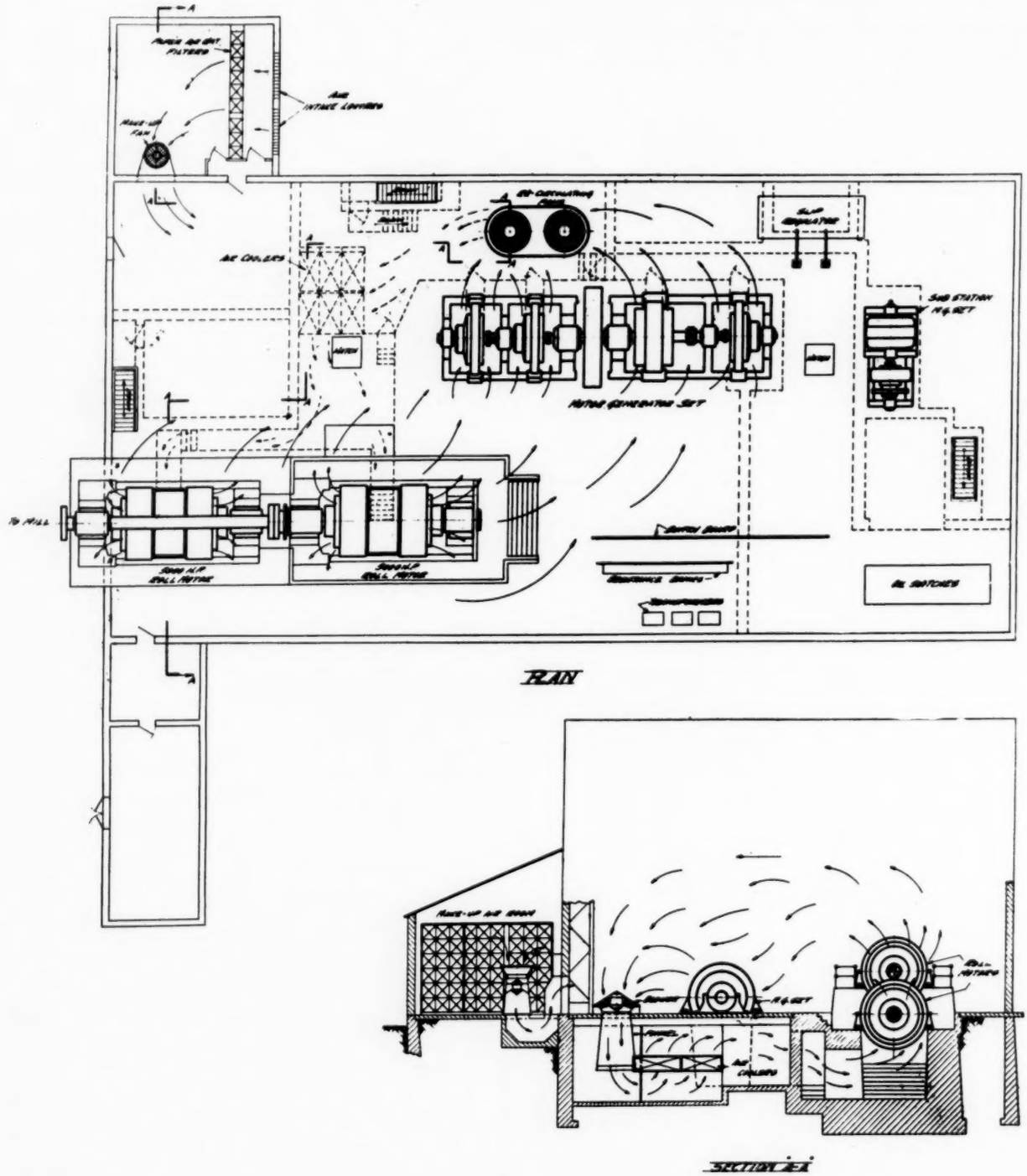


FIG. 3.

path and sends it through four other sets of eliminators to a main tunnel. The purpose of these eliminators is to remove dust and as much as possible of the suspended moisture picked up in the spray chamber. From the main tunnel, the air is divided into branch paths, one for the 6500 HP roll motor and one for the motor-generator set. Air checks are provided in all branches of the tunnel. The air for the set is further subdivided to allow each of the two generators and the induction motor to get its share.

A steam coil is located in the system just ahead of the spray chamber, to prevent freezing of the spray water in cold weather. Outside air louvers may be closed, and recirculating air louvers opened in cool or cold weather and satisfactory temperatures maintained in the motor room with a minimum use of steam.

The above described air conditioning systems

have been only moderately successful in cleaning air. Considerable heavy particles of dirt are eliminated but very fine dirt and particularly soot, have no trouble in finding their way into the motor rooms and into the machines. Therefore when the No. 1—40" Blooming Mill and 28-32" Structural Mills were changed over from steam engine to motor drive, in 1928, an entirely different system of air conditioning was installed.

The electrical equipment in the 1—40" Blooming Mill consists of 2-3500 HP-0-50-120 RPM DC reversing motors, receiving power from a flywheel motor generator set consisting of a 5000 HP wound rotor induction motor, a flywheel of 175000 HP sec. stored energy, and 2-3000 KW DC generators. A series connection is used, with the midpoint of the generators grounded, giving a 1500 volt circuit with a potential of 750 volts to ground. In this same room is also a 1000 KW synchronous motor generator set supplying 250 volt direct current mill auxiliaries.

A dry type air conditioning equipment was installed. The incoming air is drawn through eliminators to endless screens. These screens are rotated 3" per hour and at the bottom are immersed in oil. Since the screens are approximately 216 inches long, the entire surface is cleaned by the oil in the bottom tank, once in 72 hours. The rotating action is intermittent, normally, but by causing the driving motor to operate continuously, the complete rotation can be accomplished much more quickly if desired. The total area of screens, one side only, is 131 sq. ft. The air requirement for this installation is 65000 CFM giving a velocity of 500 ft. per minute. It should be noted that the air must pass through both the front and rear areas of the endless screens. The air then passes to air mats or filter papers. These are arranged to give 7.5 times the area of the oil screen with a resultant air velocity of 60 to 70 feet per minute. From the air mats the air is drawn to one of two fans, each driven by a 75 HP motor, and delivered to a tunnel leading to the reversing motor and the motor generator set. Recirculating louvers were provided and are used in cold weather to control motor room temperatures. In warm weather no recirculation is employed.

The electrical equipment in the 28-32" Structural Mill motor room consists of a flywheel motor generator set made up of a 7500 HP 375 RPM motor, a flywheel of 175000 HP sec. stored energy and 3 generators of 3000 KW capacity at 750 volts, and a 3500 HP 0-50-120 RPM 750 volt DC reversing motor driving the 32" mill. The 6000 HP 0-70-140 RPM motor driving the 28" Finishing Mill is in a separate room, connected by a tunnel used to accommodate the bus bars and ventilating air for this motor. The air conditioning equipment is similar to that employed at the No. 1-40" Blooming Mill, namely oiled screens and air mats. Due to the fact that the 28" mill motor is remote from this room, none of its air can be recirculated. The air discharged into the 32" motor room may be recirculated. Since the greater proportion of air must be taken from out doors at all times, steam coils were installed ahead of the oil screens to temper the incoming air during cold weather. 95000 CFM of air is required for this equipment and is circulated by either of 2-125 HP motors driving suitable fans.

The two equipments just described were very effective in cleaning the air coming into the motor rooms. The oiled screens removed considerable quantities of heavier particles of dirt. However sufficient quantities of dirt passed the screens to completely choke up the air mats in a few days operation. The air mats as installed were in a practically horizontal position and could not be cleaned except by removal of the individual frames. Soon after these installations were made information became available relative to mounting these mats in an almost vertical position and equipping them with hand or motor operated rapping devices. With such an arrangement which allows the accumulated dirt to be quickly and cheaply removed, the life of the filter papers is greatly extended and maintenance reduced to a reasonable figure. However space limitations prevented such a rearrangement in the cases just described and due to excessive maintenance cost the use of the air mats was abandoned. Using the oiled screens above, the effectiveness of these air conditioning equipments is comparable to that of the wet types previously described.

When the construction of the Illinois Beam Mill was started in 1930 it was realized that no-one of the existing types of air conditioning equipments at South Works was desirable for the new mill. It was therefore decided to develop the idea of recirculating the motor room air. This scheme requires the use of surface type coolers in the path of the air, to remove the heat picked up from the machines. The amount of heat to be removed corresponds to the total losses in all machines, less the heat radiated by the walls and ceiling of the motor room. By employing a make-up fan of relatively small capacity, delivering air to the motor room through a reasonably good air filter, very little dirt is introduced into the room. Furthermore the make-up fan maintains a positive pressure in the motor room and all leakage is outward, preventing the infiltration of mill dirt.

The equipment in the 54" Blooming Mill of the Illinois Beam Mill consists of 2-5000 HP 600 volt DC reversing motors and a motor generator rated as follows: Induction motor 6500 HP, 3-3500 KW 600 volt DC generators and flywheel, with slip regulator and exciter sets. A 1000 KW synchronous motor generator set supplies 250 volt direct current power for mill auxiliaries. Two propeller type fans each rated at 70000 CFM against 5.5" static pressure and driven by 75 HP 1450 RPM motors are located near the main motor generator set. Air is drawn across the motor generator set and delivered to a basement. The air then passes through a surface type cooler and is delivered to the reversing motors and thence back into the motor room. Air make-up is provided by a 30000 CFM fan drawing air through air mat cleaners.

The coolers consist of 3 units of 50000 CFM capacity requiring a total of 1125 GPM of cooling water. The water is not wasted but passed on to the mill for use on rolls, reheating furnaces, etc. This amount of cooling water will absorb 1125 x 8.34 =9400 B.T.U. per degree rise in temperature. Operating data show a rise of 8°, indicating the removal of 75000 B.T.U. per minute from the circulating air. The specific heat of air is 1238 B.T.U. per pound. At the temperature and pressure obtaining in this

case, the weight of air is .07 lbs. per cu. ft., giving a specific heat of .016 B.T.U. per cu. ft. With a circulation of 140,000 CFM a lowering of air temperature of one degree would require the removal of 140000 x .016 = 2240 B.T.U. The actual drop in air temperature would then be 75000 ÷ 2240 = 33.5° F., which checks approximately with operating conditions. Air enters the coolers at 115° to 120° F and leaves at 80° to 85° giving a drop of approximately 35° F.

The losses in drives of this type are high since the overall efficiency of three machines, the induc-

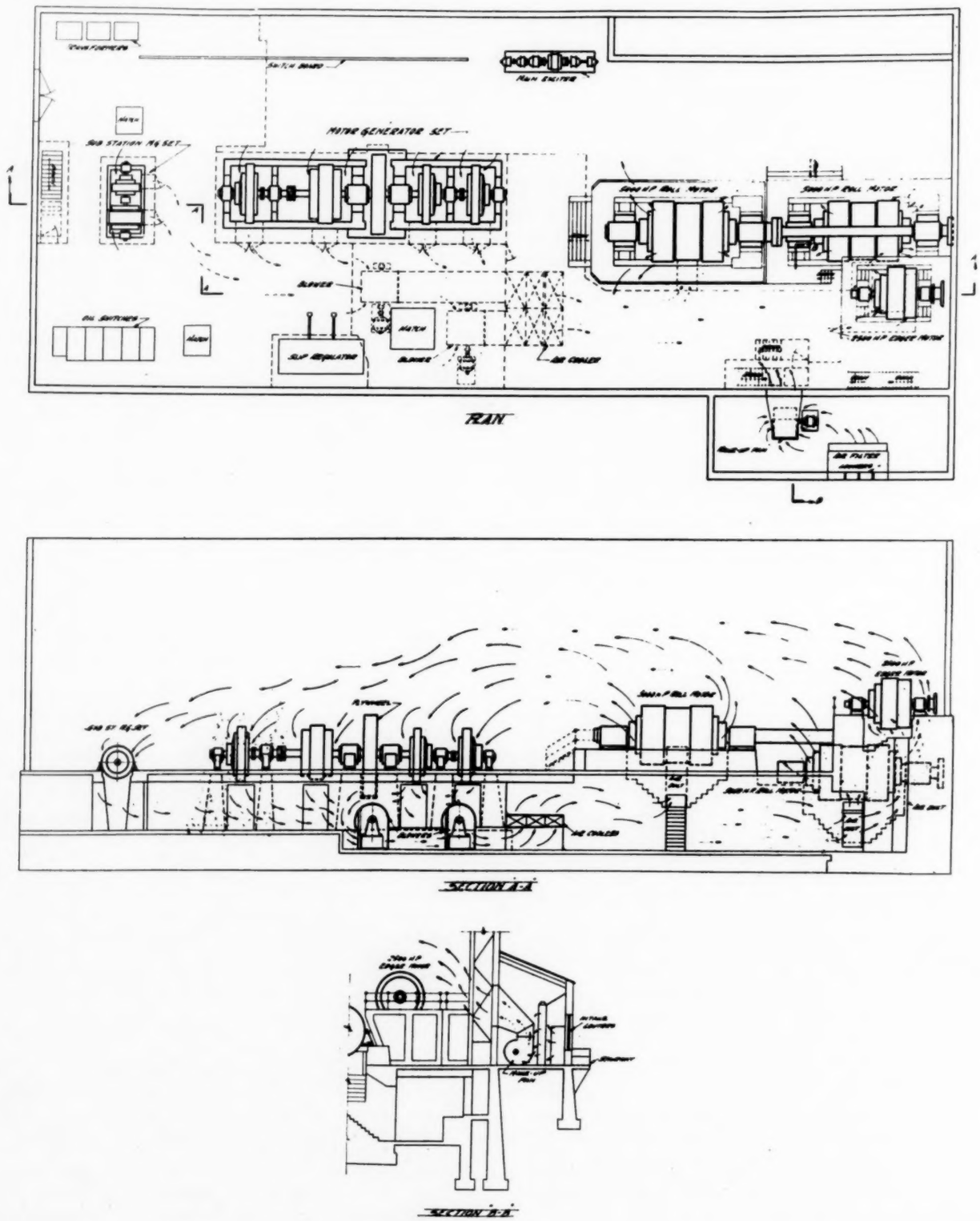


FIG. 4.

tion motor, the generators and the roll motors, must be taken into account. An efficiency of 80% overall is a reasonable figure. With a maximum hourly demand of 6000 KW on this mill, the losses would be 1200 KW or 68000 B.T.U. per minute, which is within the rating of the cooling equipment. In cool weather satisfactory temperatures can be maintained with only one fan running, circulating 70000 CFM of air.

Similarly at the 52" Structural Mill Motor Room of the Illinois Beam Mill, which houses the electrical equipment for the roughing and intermediate mills, totalling 55000 KW capacity, there are three fans duplicate of those just described, giving a recirculating capacity of 210000 CFM of air and requiring 3-75 HP motors. The make-up fan is of 30000 CFM capacity. Five coolers totalling 250000 CFM capacity are provided using 1870 GPM of cooling water.

This system has given the desired results, namely an air conditioning equipment requiring little maintenance, and one which is very effective in keeping mill dirt out of the motor room.

A similar system was installed at the 44" Slab Mill. Here the roll motors consist of 3-700 volt reversing DC motors totalling 12,500 HP. The combined capacity of all equipment in this motor room is 25,500 KW. Fans totalling 170,000 CFM, driven by 2-150 HP 715 RPM motors circulate the cooling air and the make-up fan of 50000 CFM capacity is driven by a 30 HP 715 RPM motor. A cooler, consisting of 3 units totalling 171,000 CFM and requiring 1350 GPM of water is used to cool the air. The fans are located in the basement insuring that all air is drawn down through the pits of the motor generator set. This arrangement is more effective in confining the heat due to losses in the motor generator set to the basement, than the system at the Beam Mill. This feature is important in lowering motor room temperatures, since the air delivered to the motor room contains only the heat due to losses in the roll motors.

The 96" Plate Mill consists of 3- roughing stands driven by a 4000 HP—375 RPM—6600 volt wound rotor induction motor, and six finishing stands driven by six 3500 HP —600 volt DC motors, 165-330 RPM. Power for the finishing stand motors is supplied by 2-6000 KW synchronous motor generator sets. Three 1000 KW motor generator sets furnish 250 volt power for mill auxiliaries. The total KW of electrical equipment in this motor room, including auxiliary transformers, exciters, fan motors, pump motors, etc. is 35,500 KW.

Here again a recirculating air system was installed with a fan capacity of 240,000 CFM at 5" pressure and a make-up fan of 50,000 CFM at 3.75" pressure. Coolers were provided and the system is similar to that just described for the 44" Slab Mill.

The 10" Alloy Bar Mill, also installed in 1931, has nine motors totalling 7600 HP. They are 600 volt adjustable speed and employ rheostatic starting equipment. Power is supplied by 3 synchronous motor generator sets totalling 5250 KW capacity. The total capacity of electrical equipment in this motor room is 12,500 KW. This motor room is of low roofed construction. A recirculating system of air conditioning was installed to prevent excessive temperatures. The system is similar to those already described with the following exceptions. Each unit of the motor-generator sets is shrouded in such a manner that all windage from the machine is delivered to the basement, and with it practically all heat due to losses in the machine. The previously described systems drew air through the motor-generator pits and carried a part of such losses to the basement. However the windage of the machines throw out into the room a considerable part of the heat losses of the motor generator sets.

Two fans of 50,000 CFM capacity at 4.5" static pressure are employed to recirculate air and are driven by 60 HP 750 RPM motors. The coolers have an equivalent capacity and require 800 GPM of water.

The accompanying diagrams show the principal features of the various types of air conditioning equipment in use at South Works. Fig. 1 shows the wet non-recirculating type of equipment in use at the 35" Blooming Mill. Fig. 2 shows the dry non-recirculating type apparatus at the No. 1-40" Blooming Mill. Fig. 3 shows the dry recirculating installation at the 54" Blooming Mill of the Illinois Beam Mill. Fig. 4 illustrates the second stage in the development of recirculating equipment as installed at the 44" Slab Mill.

Sheet Sorting Machine

By J. FARRINGTON
Electrical Supt., Wheeling Steel Corp.,
Steubenville, Ohio,
and

F. S. MILLER
Supt., Scale Dept., Wheeling Steel Corp.,
Steubenville, Ohio.

In the manufacture of sheets and tin plate the difficulty of rolling uniform gauges is common knowledge. As all sheets and tin plate are sold on base weights it is necessary to weigh the individual sheets either by the slow method of weighing each sheet on a scale by hand or by employing women to estimate the weight by picking up each sheet. The first method is too slow and costly and the second, while faster, is not as accurate as desired by the manufacturer. In order to obtain both speed and accuracy we have developed, manufactured and patented an automatic Sheet Sorting Machine for sorting tin plate sheets varying from 14" wide by 20" long to 30" wide by 40" long, in gauges ranging from 24 to 38.

This machine is capable of sorting sheets into three weights—light, medium and heavy, the medium sheet being the required base weight one, at an average rate of 1500 per hour for sheets 30" x 40" (or 12 base boxes) to 1800 per hour for sheets 14" x 20" (or 16 base boxes). The machine has been in continuous production day and night since December 1931 with the exception of holidays and has sorted 13,880,000 sheets up to March 1, 1933 at an average

cost of replacement of parts per month of slightly less than two dollars ($2.00).

Following is a description of the design and operation of the machine:

DESIGN

The machine consists of three essential features —the feeding, weighing and discharging mechanisms:

FEEDING MECHANISM

The feeder in the single machine is composed of a feed roller "B" that is raised and lowered by a variable speed motor "P" and feeds the sheets at the correct speed, depending upon the size sheets being weighed, upon a constant speed belt conveyor "C" which, in turn, delivers the sheets on to the scale table "D" of the weighing mechanism to be weighed.

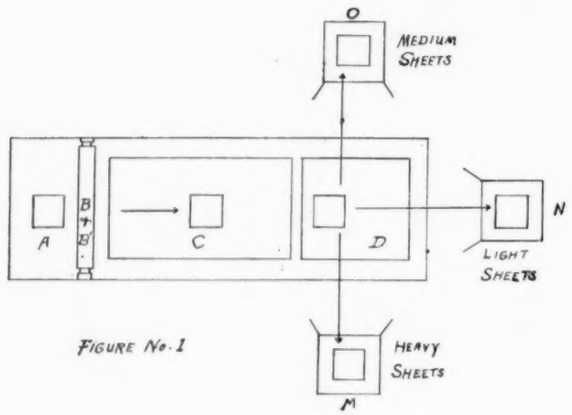


FIGURE No. 1

FIG. 1.

The feeder in the duplex machine consists of a Dexter Feeder A′ with a lifting and lowering conveyor, driven by a variable speed motor "P", which feeds the sheets at the correct speed upon an upper and lower constant speed belt conveyors "C" and "C′" which, in turn, deliver the sheets on the upper and lower scale tables "D" and "D′" of the weighing mechanism to be weighed.

WEIGHING MECHANISM

The weighing mechanism consists of a standard scales with an inverted pointer upon which is mounted in the place where articles are usually weighed, a scale table the belts of which are driven by a constant speed motor attached to the scale table. The scales are mounted upon a stationary base.

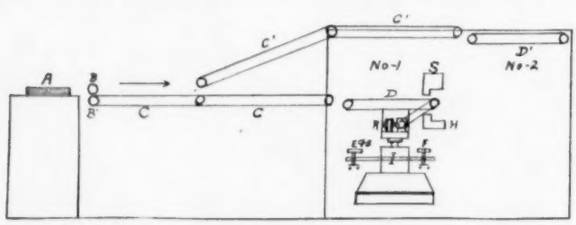


FIG. 2.

The movable make and break contacts "E", "F" and "G" mounted on the scale levers "I" of the scales, make contact with the three stationary contacts mounted on the stationary base and close the electric circuit to one of the three magnets, depending upon whether the sheet is a light, medium or heavy one. The three stationary electric contacts which require very close adjustment in order to get accurate weights are raised and lowered by means of a small gear reducing unit, hand operated, located on the stationary base.

The scales are equipped with an inverted pointer which, by means of a magnifying glass and mirror, shows to the operator the exact weight of the sheet and thus permits him to check the performance of the machine.

DISCHARGE MECHANISM

The discharge mechanism consists of three steel rollers K-1 rotating in a left hand direction, three steel rollers J-1 rotating in a forward direction and three steel rollers L-1 rotating in a right hand direction, mounted one inch above the scale table belts and driven by one constant speed motor "G". Mounted directly above each set of three steel rollers are magnets "K", "J" and "L" whose circuit is actuated by the electric contacts "E", "F" and "G" on the scale levers and a photo-electric relay "H".

Ball bearings are used throughout the machine.

All the machinery is carried on one rigid structural steel framework, thus making it portable. Each one of the three motors "P", "Q" and "R" have their own separate switch and starter and a separate switch feeds the three magnets.

An indicating lamp is mounted on top of the discharge mechanism which lights each time a magnet is energized.

OPERATION

When a single machine is used the pile of sheets to be weighed is placed on the table marked "A" and fed by an operator one at a time between feed roll "B" and roll "B-1" of conveyor "C", feeding it at the proper rate upon conveyor "C".

Conveyor "C" delivers the sheet upon the running scale table "D".

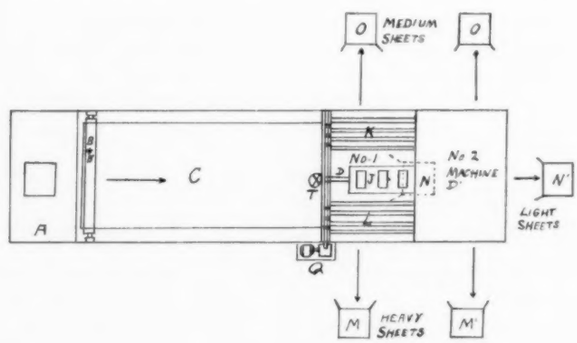


FIG. 3.

The scales are set to a predetermined weight so that the correct weight sheet will bring the scale pointer to the zero mark. If the tolerance on the sheet is, say, two (2) ounces minus and plus the light and heavy contacts are adjusted to operate when the weight differs from that amount. When the sheet is delivered upon the running scale table "D" its weight begins to move the scale lever "I". If the sheet is a light weight one, weighing less than the two (2) ounce tolerance, the scale lever "I" moves automatically only enough to cause the light weight contacts "E" to close the electric circuit to the middle or light weight magnet "J". In series with this contact "E" is a photo-electric relay "H" which operates, when the sheet intercepts its light source "S", completing the circuit to the magnet, causing it to magnetize the rotating rolls "J-1" Figure No. 3 which lifts the sheet from the scale table "D" Figure No. 2 and discharges the sheet forward into a chute or piler "N" Figure No. 1 thus allowing the scale table "D" to return to its OFF position ready for the next sheet.

When a magnet is energized the lamp "T" lights, showing the operator the magnet has functioned and, by looking in the mirror at the pointer, he can see if it has functioned correctly.

If the next sheet is a medium one its weight moves the balancing lever "I" Figure No. 2 causing it to first close the light weight contact "E" but, as the sheet has not intercepted the light source "S" of photo-electric relay "H", the light magnet "J" is not energized, the scale lever continuing to move next causes the medium contact "G" to close and, if it is closed when the sheet intercepts the light "S" of the photo-electric relay "H" causing it to close, the medium or left hand magnet "K" is energized, which magnetizes the three left hand rotating rollers "K-1", which lift the sheet from the running scale table "D" and discharges the sheet to the left into a chute or piler "O".

If the next sheet is a heavy one weighing more than the tolerance required it will move the balancing lever "I", closing both the light contact "E" and medium contact "G" but, as the sheet has not intercepted the light source "S" of the photo-electric relay "H", the circuit is not completed and the light and medium magnets are not energized. The scale lever continuing to move, next causes the heavy contact "F" to close, and if it is closed when the sheet intercepts the light source "S" to the photo-electric relay "H", causing it to close, it will complete the circuit to the heavy, or right hand magnet, "L", causing it to magnetize the three right hand rotating rollers "L-1" which lifts the sheet from the scale table "D" and discharges the sheet to the right onto a chute or piler "M".

The contacts "E", "F" and "G" are interlocked so that when any one is closed the circuit is opened on the other two, thus preventing more than one magnet being energized at one time.

We are now preparing to build a duplex machine that will have a capacity of 3400 sheets per hour, operated by one operator.

Rod Mill Control Problems

By G. O. VAN ARTSDALEN
Electrical Supt., Henry Disston & Sons, Inc., Philadelphia, Pa.

Presented before the Philadelphia District Section of the A. I. & S. E. E., April, 1933.

This paper deals with the conversion of a 9" rod mill main roll drive from manual to automatic control. The mill in question was a single speed mill with three high stands for rolling small shape bars and wire. It was driven by a 500 HP., 495 RPM, 2 phase, 2400 volt slip ring motor connected to the mill by a 44", 3 ply belt, 105 ft. long. The starting control was manually operated and consisted of a 3 pole, 2400 volt oil circuit breaker for energizing the stator circuit, with acceleration taken care of by means of a 13 point radial controller connected to secondary grid resistors.

This drive has some history connected with it as at the time it was installed, twenty years ago, it was the largest on the Philadelphia Electric system, in the northern part of the city. A signal system was installed between the old Lardner's point generating station and our plant, whereby the mill operator, before starting the motor, first notified the Lardner's point operator, who stood by his controls and expected immense disturbances. Our mill operator would then close his oil circuit breaker and commence cutting out resistance in the rotor circuit. This he did so slowly that by the time he had reached the last point at least five minutes had elapsed. This time was fixed by the Philadelphia Electric Co., and the belt manufacturers, both of whom anticipated trouble with quicker acceleration. You can easily see that the time wasted by this method was considerable when the mill made as many as eight or ten stops in a day's run, depending on the kind of work being rolled.

The successful operation of automatic control in another of our mills, eliminating the motor operator and giving more constant motor performance, brought into consideration the changing of the control on this mill from manual to automatic.

Present practice on large motors indicated that we should be able to accelerate to full speed in 45 seconds to 1 minute, and in five steps instead of thirteen which were used. However, the quicker acceleration, especially with the mill screwed down tight, placed extra stress on the belt. Tests of this quicker acceleration were made, using the manual control and nothing serious happened, except the opening of the oil circuit breaker at the Power House. As the motor was on a separate circuit by itself, this was set at a higher value and no delay was caused to others.

From these tests, it was decided to replace, the

old controller with magnetic contactors actuated by definite time relays and regroup the secondary resistor sections of the former installation. The main problem was the regrouping of the secondary resistor sections to give smooth acceleration. Starting the mill is always like starting so many brake drums

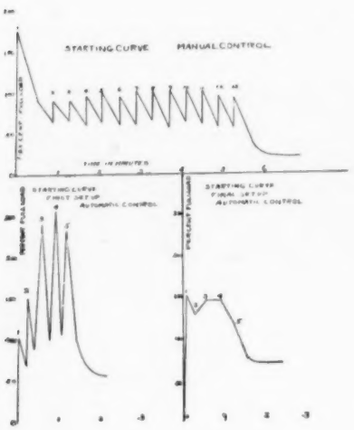
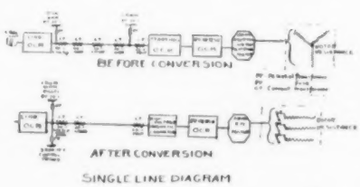


Chart showing starting curve on manual control and curve on first set up and final set up on automatic control.



SINGLE LINE DIAGRAM

A comparison of single line diagrams showing the elimination of considerable metering and protective equipment.

with brakes applied, for the rolls are never loosened except to change them. Another problem was when the mill was rolling small sizes of wire, this kind of work necessitated the rolls being clamped in the mill housing unusually tight to maintain size. This condition required unusually high torque to start the motor and a maximum torque button was installed to take care of this condition, where by using this the motor started with the first step of resistance cut out. All the data available was collected and a grouping decided upon.

Installation was started when the mill was operating four days a week so that we did the work piecemeal, working Saturday and Mondays only. The first section installed was the panel containing the high voltage contactor. The old oil circuit breaker was removed and the contactor put in its place with a push button station mounted temporarily. The next step was the removal of the radial controller and installation of the accelerating contactors. This meant considerable heavy work for the rotor circuit was wired by heavy cable to take care of 600 amps. Our work was lightened somewhat by the fact that we removed a 13 point controller and installed only a 5 point.

A trial of the first hook-up did not work out so good. Our first assumption was that the motor would stand, at least, 250 percent of normal full load current for starting. It probably would stand considerably more but as the source of power was our own generating plant which a suddenly applied load of 250 amps may upset, we tried to keep below that for the initial inrush. Our first grouping gave extremely high peaks on the 3rd, 4th and 5th points. The reason for the high peaks on the 3rd, 4th and 5th was found to be too much resistance between points 1 and 2, causing a drag and sluggish acceleration so that when point 3 was reached, the motor speed was still too slow. By cutting and trying, we finally reduced the resistance between points 1 and 2 so that the rate of acceleration was increased and while the current was higher than the first point of the other arrangement, it was never higher than 60% of full load current and the current on points 3, 4 and 5 was reduced to approximately the same amount. This arrangement was decided on as the best. Higher inrush of current on the first point also gave sufficient torque so that the necessity of a maximum torque button was eliminated.

This comparison of single line diagrams, showing equipment in use with the old system and that of the new, shows the elimination of considerable metering and protective equipment by the installation of current and potential transformers of larger capacity.

Another feature of this installation was the addition of bearing temperature relays. Not a new device by any means and the opinion of some was that money spent for them in this case was wasted as the motor had been operating without them for 20 years and had never had trouble due to an overheated bearing which was true. This drive had been operating automatically for 2 years and 3 months and two months ago the mill shut down from an overheated bearing which was saved from burning out entirely by the timely operation of a bearing temperature relay. The cost of replacing this bearing would have been far greater than the purchase price of all three relays.

The cost of the new equipment, together with its installation by our own force was small, and due to the fact that the old method required an operator in attendance all of the time, the outlay for both equipment and installation was returned in 18 months by the elimination of the operator. Now the mill foreman stops, starts jogs, etc., with very little trouble so the improvement and saving in the cost of mill operation are well justified by the installation.

THE OCTOBER ISSUE

OF THE

IRON AND STEEL ENGINEER

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CONVENTION ISSUE

This issue will contain papers, programs, and plans in connection with the A. I. & S. E. E. Convention and Exposition to be held in Pittsburgh, October 17-19, 1933.

ADVERTISING SPACE NOW BEING RESERVED

Diesel Electric Locomotives

By A. H. CANDEE
Railway Engineer, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Presented before the Birmingham District Section of the A. I. & S. E. E., January, 1933.

Three years ago, on March 29, 1930, I had the pleasure of presenting a paper before this section on the subject of "Locomotives With Internal Combustion Engines for Steel Mill Transportation." Tonight I will confine my remarks to the Diesel electric type of locomotive because this subject has broadened until it warrants undivided consideration in itself.

Internal combustion engines were applied to rail vehicles as early as 1890 in the United States, but it was not until 1925 that Diesel engines were applied to rail cars and locomotives in the United States and Canada. Thus, the Diesel locomotive was but 5 years old in 1930 and although still young in years, much valuable experience has been gathered which definitely shows the economies and reliability of this form of motive power. The past three years have been a period of operation somewhat free of development changes, by which the true worth of the Diesel engine as a source of motive power in rail vehicles may be gauged. While development work during this period has not ceased, nevertheless it has been retarded by general business conditions, the basic development work having been carried through prior to 1930.

It is probable that most of you are familiar with the design of Diesel locomotives. However, I hope you will forbear a necessarily brief description of the details of construction and functions of the various parts of such locomotives, so that you may all be up-to-date on the modern type of unit.

Any locomotive, in its essentials, consists of a set of mechanical parts on wheels arranged to move burden bearing cars along tracks, and equipped with apparatus for applying power to the wheels for propulsion purposes. In the case of the Diesel electric locomotive, the power is generated by a Diesel engine and is transmitted to the wheels by electrical means. These three components then—a set of mechanical parts, a Diesel engine, and an electrical transmission system—comprise the basic items around which such a locomotive is built.

Little need be said in regard to the mechanical parts design, as this art has been developed by years of steam and electric locomotive construction and operation. Some of the factors which must be considered in laying down the type of running gear to be suitable for a specific service are track gauge, locomotive weight, permissible wheel loads, number of axles to be driven, track curves, speeds, type of service, clearances, and amount and weight of power equipment to be installed. The simplest form of construction is obtained by mounting the axles in a rigid frame integral with the locomotive superstructure, but such a unit is adaptable only for relatively light locomotives and for heavier locomotives where the curves are easy. On account of tracking characteristics, speeds must be kept low.

70-Ton, 300 HP. Westinghouse Oil Electric Locomotive for Industrial Switching Service.

The two axle swivel truck type of running gear seems to be the most adaptable for general switching and transfer service and is built for locomotive weights up to 130 tons and for speeds up to 50 miles per hour, which is high enough for practically every purpose except for main line freight and passenger service. The rigid wheel base of the swivel truck may be kept short, so that sharp curves may be negotiated and, because of the four axles, the wheel loads may be kept well within the limits set by the railroads to permit operation over nearly any kind of track.

For main line work where high speeds are necessary it is customary to provide guiding axles for either rigid frame or truck type locomotives to improve tracking characteristics, but as there are few of these locomotives under consideration at this time, the general description of Diesel locomotives will be confined to the swivel truck type, which is generally adaptable to steel plant rail transportation.

The Diesel engine is the main item for consideration at the present time, as it is the only part of the locomotive which has had to build a record of satisfactory performance before general acceptance by transportation men. This type of engine, originally developed late in the Nineteenth Century, had built up a creditable record in marine and stationary work but designs suitable for rail transportation were not available until 1924. In this year a British aircraft Diesel engine was modified and strengthened and placed in rail service in Canada in 1925. At the same time an engine manufacturer in the United States built an engine suitable for locomotive work and put three in operation in 1925. These two types of engines are the only ones which have had wide application in this country up to the present time. A new engine has recently been put in locomotive service but its suitability for rail propulsion has yet to be proved.

The two types of engines which have had wide application for rail propulsion differ radically in one fundamental point—that of speed of operation. The type developed from the aircraft engine was built for 800 R.P.M. and later improvements in this design have allowed an increase in speed to 900 R.P.M.

with very satisfactory results. The other engine was first built and operated at 600 R. P. M. but later dropped to 550 R.P.M. because of dangerous critical vibrations at the higher speed.

The aircraft engine was built by the William Beardmore Company of Glasgow, Scotland, and the rights to build this engine in the United States were acquired by our Company. I will attempt to describe our modification of this engine as representing the most modern design of Diesel for rail purposes.

The engine operates on the conventional 4 stroke cycle principle, drawing only air into the cylinder on the suction stroke, compressing it to approximately 420 pounds per square inch on the next stroke, near the end of which stroke fuel is injected into the cylinder under high pressure through a nozzle arranged to atomize the fuel. Injecting the vaporized fuel into the extremely hot air which results from its compression causes combustion of the fuel, after which the expansion and exhaust strokes are similar to those of the 4-cycle gasoline engine. There is nothing mysterious or complicated about a Diesel engine of this design. The general construction of parts is exactly parallel to that of similar parts of millions of gasoline engines in operation throughout the world. The only difference lies in the method of introducing and igniting the fuel.

The back-bone of this engine is the crank case, which is an integral steel casting of high strength and light weight. It supports all of the component parts of the engine—the crank shaft, cylinder liners, cylinder heads, fuel pumps, water pump, cam shaft, and gearing for auxiliary devices. A diaphragm across the lower portion of this casting divides the cooling water space from the lubricating oil spray at the crank shaft. The cylinder liners are inserted from top to bottom through the water jacket, so that they are surrounded by cooling water, and are clamped down on gaskets at the upper end by the individual cylinder heads which are bolted to the crank case. Rubber cylinder sealing rings are provided at the points where the liners pass through the diaphragm and effectually prevent leaks from the water jacket to the lubricating oil sump. These cylinder liners are of a special grade of cast iron and are easily removable after the cylinder heads have been taken off, thus allowing a reconditioning of cylinders at a minimum expense.

Separate cylinder heads are provided—one for each cylinder. They are cast of aluminum and are very light so that one man may remove a head without difficulty. Two inlet and two exhaust valves are provided in each head, these valves closing against steel seats cast into the head. Ample provision for cleaning and inspecting water passages is arranged.

The crank shaft is a large sized chrome nickel steel forging machined all over and counter-balanced. It is drilled for pressure lubrication from main bearings to crank pins. Main bearings are provided at the ends of the engine and between adjacent cylinders. The cam shaft is made from special heat-treated steel, the cams being forged integral with the shaft which is then machined all over. This shaft is located in a cored out chamber in the upper part of the crank case to permit of short valve push rods.

Pistons are of a special aluminum alloy. The piston pin is of highly polished steel bored out so as to reduce weight, and is full floating. This piston pin is lubricated by pressure oil from the crank pin bearing through a pipe clamped rigidly to the connecting rod. The connecting rods are steel forgings heat-treated and of light weight and ample strength. The main connecting rod bearing is a removable bronze shell lined with babbitt, while the piston pin bearing is a bronze bushing.

Six individual fuel pumps are provided, one for each cylinder. These are assembled in a fuel pump housing and are bolted to the side of the engine. Fuel is pumped by these individual pumps to nozzles located in the center of each cylinder head. These pumps raise the pressure for injection to several thousand pounds to insure that the oil is thoroughly atomized as it enters the cylinders through the injection nozzles. A very unique method of metering the amount of oil is embodied in each of these pumps, the quantity of fuel being determined by a variable surface on the fuel pump plunger. As the plunger moves up, the upper horizontal edge of this surface covers the fuel inlet opening and pressure immediately builds up for injection. However, as the plunger moves farther up, the lower edge of this surface, which is cutaway helically, again uncovers the fuel inlet port, thus acting as a bypass and relieving the pressure. By turning the plunger, one way or the other the length of time that the inlet port is covered may be varied to suit the exact amount of fuel desired, and the injection is extremely sharp. The injection nozzle is so arranged that it does not open to admit fuel to the cylinder until the injection pressure has reached 1800 pounds. When it is realized that the amount of oil which must be injected at one time is about that quantity which will lie on the surface of a cent and that the time allowed for metering this amount of fuel is approximately one thousandth of a second, it may be realized that this has been one of the problems of the past. The present fuel injection system, which we are using, has had remarkable success from this standpoint. The fuel pump design and the atomizer nozzle design are such that the parts may be easily disassembled for cleaning. Cylinder, plungers, needles, valve seats, and other such parts may be renewed individually and this results in reduced maintenance costs.

A gear train for driving auxiliaries is arranged in a housing which is bolted to the front end of the engine. This gear train is driven from the crank shaft and provides for the operation of fuel pump, water pump, cam shaft, lubricating oil pumps, and the governor mechanism.

The governor is unique in that it consists of a gear type of pump forcing oil into a chamber having a variable orifice. With this arrangement at any orifice opening, the pressure within the chamber is a function of the speed of the gear pump and consequently is a function of the engine speed. This hydraulic pressure is arranged to operate a piston for increasing or decreasing the amount of fuel injected into the cylinders by the fuel pumps. By changing the size of the orifice by means of a needle valve arrangement the engine speed at which a given pressure is developed may be varied over a wide range. This type of governor is, therefore, a truly variable speed governor and is extremely sensitive. No other engine as yet developed for rail propulsion

has this essential feature. It must be realized that the Diesel engine differs from a gasoline engine in that while neither is capable of sustaining overloads without an increase in the amount of fuel fed to the engine, this increase is somewhat automatic for the gasoline engine. This means that on account of varying auxiliary load demands at engine idling speed, careful governing of the Diesel is essential. A gasoline engine, while idling, will take a load and the slight speed reduction caused thereby results in an increase in torque to carry this extra load.

One feature which is embodied in our engines and which is not found in any other engine for rail propulsion purposes is the vibration damper. Every engine in operation has certain critical speed points, at which considerable damage may result from harmonic vibrations. The application of a damper to an engine minimizes the effect of critical vibrations at these critical speed points and thus allows safe operation over a wide range of speeds. This is one of the features which permits the operation of our engines at much higher speeds than other engines have been able to operate.

Forced lubrication is provided for all moving parts. Oil from the oil reservoir is pumped under pressure to each main bearing of the crank shaft from which the oil is carried to the connecting rod bearings, to the piston pins and is also sprayed to the cylinder walls. Forced lubrication of the cam shaft, valve rocker arms, gear train, fuel pump parts, and all other moving parts is obtained from this same pressure lubricating oil system. A safety trip is provided on the front end of the engine so that should this pressure fall below 10 pounds per square inch, the engine fuel will be tripped and the engine stopped.

The engine operates on the dry sump principle, that is, the lubricating oil which drops from the crank shaft bearings and cylinders is not permitted to remain in the engine sump. A lubricating oil scavenge pump forces this drainage through filters and the oil cooling radiators back to the oil storage reservoir which is located in a separate compartment of the bedplate.

One of the essential details of a Diesel locomotive is the method of transmitting power from the prime mover to the axles of the locomotive. Various types of drive have been tried, including mechanical transmission, hydraulic transmission, steam transmission and electric transmission, but so far the only one which has proven successful, except in the very small sizes, is the electric transmission. This consists of a generator driven directly by the engine and generating electrical energy for the operation of electric motors geared to the locomotive axles. The generator is of the variable voltage type and the motors are invariably of the series type. The method of control of the voltage characteristics of the generator to secure the maximum effectiveness in power application has differed on locomotives of different manufacture, but in each case the aim is to transmit as much of the full engine horsepower to the traction motor as may be possible. To accomplish this it is necessary to reduce the electrical losses in both the motors and the generator to the extreme and to make sure that the voltage is kept as high as is possible dependent upon the current demand of the traction motors.

The generator is of the direct current type, and since it is independent of any fixed voltage system the designer usually selects that voltage which results in maximum economy of materials and gives the lowest losses. In general, a satisfactory maximum voltage varies from 600 to 750. Traction motors may either be built for operation on this voltage or may be connected two in series and designed for half voltage.

The size of motors used for any locomotive depends upon its weight (which determines the maximum tractive effort required) and the type of service. This motor size is nearly independent of the size of power plant installed. The generator is then applied to suit the engine speed and the voltage and ampere characteristics of the motors. It has been found that the lowest electrical losses result with the motors connected in series relation for high tractive efforts and in parallel for high speed service.

With electrical transmission there is a convenient source of power available for the operation of such auxiliary locomotive apparatus as water cooling fans, air brake compressors, control, electrically-driven pumps, and storage-battery charging. While these auxiliary functions may be considered parasitical, they are essential nevertheless. It is these details which have required a great deal of engineering thought in order to insure their correct functioning under all conditions of main generator voltage. It has been found expedient to bolt a small generator onto the main generator shaft for the purpose of caring for some of this auxiliary load, especially main generator field excitation, this machine being called an auxiliary generator.

The main generator is coupled to the engine directly without any flexibility whatsoever between the crank shaft and the main generator shaft. For this reason the main generator is built with a single anti-friction bearing at the end opposite the coupling and the crank shaft supports a portion of the weight of the generator armature. The generator frame is mounted on a bedplate which is common to the engine, thus tying the engine and the generator frame together rigidly. This bedplate forms the sump under the engine crank shaft for the draining of oil and also embodies the lubricating oil storage tank, as referred to previously.

The engine generator set is mounted directly on the floor of the locomotive in such a location as to secure the proper weight distribution on the locomotive wheels. Around this power-plant are grouped the water cooling radiators, the oil cooling radiators, the cooling fans, the fuel tanks, water tanks, storage battery, control details, and other equipment of this nature. In making a layout, it is essential that all parts be fully accessible and that the weight be distributed in order to limit the mechanical structure necessary to support this equipment.

One of the essential points is to locate the operator's compartment in such a manner that he will have the best visibility and will not be annoyed by the heat and noise of the engine.

There are three general types of locomotives. The original types were of the box cab construction, which term is descriptive of the shape of the locomotive cab. Some of the small locomotives have been constructed with close fitting hoods around the power plant to improve the engineer's visibility along

the sides of the locomotive, but this results in decreasing the accessibility to the engine and other apparatus and thus tends to increase maintenance expense. Our locomotives except in extremely large size are nearly all constructed with an engine room compartment which is of smaller cross section than the operator's compartment and yet provides ample space within the hood around the power plant and equipment for maintenance work. This combines accessibility with visibility. In addition, we have developed a dual control system for the operator's compartment, which permits full control of the locomotive movements from either side of the cab at will and allows the operator to sit on the side where he secures the best view of the ground crews and yard. This has been found to be very advantageous and makes it most desirable for single man operation.

Having reviewed the construction of a Diesel locomotive briefly, let us consider for a moment the relative serviceability of a Diesel locomotive as compared to steam motive power. The former has a much higher starting tractive effort than a steam locomotive of the same weight on drivers, due primarily to the fact that the side rod drive of the latter creates both high and low tractive effort points for each revolution of the wheels. This varies from a minimum value to a maximum at least 40 per cent higher than the minimum. With a maximum tractive effort limited by wheel slippage, it follows that the average must be low for steam, whereas with the continuous application of torque by electric motors the value may be sustained just below the slipping point of the wheels.. Thus it will be found that the steam locomotive seldom rates more tractive effort than 23% of the weight on drivers while the Diesel unit will develop up to 30% of its weight. This higher tractive effort for a given locomotive weight plays a very important role in the work which may be done by Diesel motive power

Recently it became desirable to demonstrate the reason why a Diesel locomotive of low engine horsepower could do as much work in switching service as a steam locomotive having a rated horespower 2½ times as great as the Diesel. For this purpose a number of curves were drawn. The first was a comparison of horsepowers and tractive efforts of the two types. This showed that the steam locomotive could develop more than 1500 horsepower at the rail while the Diesel delivered but 650. The maximum tractive effort of the steamer, however, was but 36,100 lbs. while that of the Diesel was 60,000 lbs. Using these data to calculate distance-time and speed-time figures it was found that performance was equal for the following runs, but if shorter movements were to be made the Diesel would be faster:

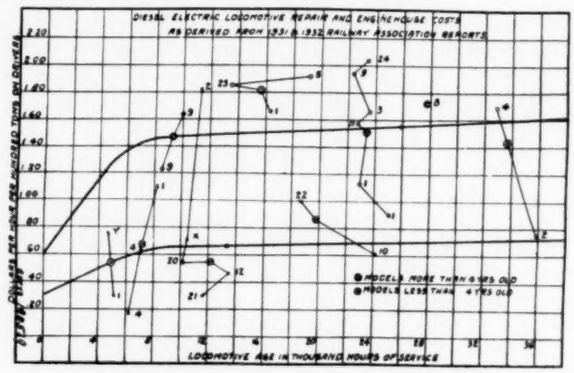
250	trailing tons	810	ft. movement
500	" "	1170	" "
1000	" "	1990	" "
1500	" "	2560	" "

These lengths of movement are way beyond those normally encountered in any switching cycle, and where time is lost on the occasional long movement it is more than made up by the faster operation on the average short run which predominate.

The effect of greater steam locomotive tractive effort may be noted by a similar comparison with a 1450 horsepower steam locomotive having a tractive effort of 51,400 lbs. maximum. In this case the Diesel outperforms the steam locomotive on runs shorter than the following:

500	trailing tons	403	ft. movement
1000	" "	519	" "
1500	" "	625	" "

We now come to the real reason for the use of Diesel locomotives—that of cost of operation. Such locomotives may have a better appearance, may be cleaner, and their characteristics may be an improvement over those of steam motive power, but unless they save money they will not be used. Fortunately operating statistics are now available which bear out the predictions of the designers that their operation is more economical than that of steam.


DIESEL ELECTRIC LOCOMOTIVE REPAIR AND ENGINEHOUSE COSTS
AS DERIVED FROM 1931 & 1932 RAILWAY ASSOCIATION REPORTS
MODELS MORE THAN 4 YRS OLD
MODELS LESS THAN 4 YRS OLD
LOCOMOTIVE AGE IN THOUSAND HOURS OF SERVICE

Diesel Electric Locomotive Repair and Engine House Costs As Derived From 1931 and 1932 Railway Association Reports.

Taken individually, various installations of Diesel locomotives have shown varying results—some saving large sums for the users and others not so much. Data of this kind could be used for or against their application, depending upon the attitude of the prospective purchaser. In order to develop the true value of the Diesel locomotive as a motive power unit, the American Electric Railway Association and the American Railway Association have gathered actual operating data from all possible sources and their 1932 committee reports tabulate this information, which has been analyzed very carefully.

The first step in making this analysis was to break down the operating costs into "per hour" figures and the costs of oils into "per gallon" figures. The information obtained in this way showed wide variations for different roads. For instance, fuel oil cost per gallon varied from $0.0286 to $0.0701 and lubricating oil from $0.245 to $0.812. Engineer's wages per hour varied from $0.61 to $1.088. Some companies reported "Enginehouse Expenses" while others did not, likewise some included "Other Expenses" while some did not. This gave such an incomplete picture of the results that it was necessary to go farther.

The next step was to identify all of the roads operating the locomotives (the reports referred to company numbers only) and the manufacturer of each. With this done, the figures began to assume shape. Grouping the figures into those applying to railroads and those of industrial operators, with due regard to the locomotive weight, it was found that the variations in operating expenses for different groups was not so marked and that industrial users operated at lower costs than railroads.

One aim of this analysis was to determine the trend of repair and engine house costs with increasing locomotive age. A study of the industrial and railroad figures, as groups, still showed considerable variation in this item which could not be satisfactorily explained. It was found, though, that the earlier models of locomotives showed higher costs than recent models and in arranging the figures on the basis of vintage a close determination could be made. The curves prepared from this analysis show definitely lower costs for locomotives built within the last four years as compared to the earlier models which were constructed with little background upon which to capitalize. Further, late operating costs are now available for modern locomotives which indicate that still lower expenses may be expected as users become more familiar with Diesel engine operation and maintenance.

The A. R. A. and the A. E. R. A. reports include steam locomotive operating statistics for comparison with Diesel locomotive figures. Without going into all of the details the general conclusions which have been drawn from the work of these National Associations are summarized:

1. Diesel fuel costs per 100 ton hours is approximately 25% of steam fuel cost with oil at 5 cents per gallon and coal at $3.00 per ton.
2. One gallon of fuel oil produces, in switching service, the equivalent of 140 lbs. of coal.
3. Diesel engine lubrication approximates 8.76 cents per 100 ton hours of locomotive switching service.
4. "Other Lubrication" cost for Diesel locomotives is 35% of steam locomotive lubrication cost.
5. The total cost of fuel, engine lubrication, locomotive lubrication and "other expenses" for Diesel locomotives is 33% of that of the corresponding steam locomotive costs.
6. One-man operation is practicable and economically correct.
7. Repair costs for industrial switching service are lower than are indicated for trunk line railroads.
8. A "unit for unit" comparison of steam and Diesel costs is not always correct, due to the fact that the number of Diesels employed for a given service may often be lower than that of steam units.
9. Modern locomotives may be operated at considerably lower repair costs than the older types of locomotives which were in the course of development at the time they were built.

We who are closely associated with Diesel locomotive design and application have not had the least doubt as to the economic advantage of this type of motive power. We now feel that our predictions have been fully verified by the two National Associations which are most interested in obtaining true facts on all railway problems.

Composition Bearings

By G. A. EBELHARE,
Supt., Synthane Corp., Oaks, Pa.

I will discuss Synthane Non-Metallic Rolling Mill Bearings—with particular reference to the use of Laminated Bakelite—The same general type of material has already been discussed under the names of Vatex and Micarta, which are Phenol-Formaldehyde products, and I do not propose to repeat data on the material already competently presented.

Neither do I propose to further establish the claims already made for the superiority of this type material over various metals. Debatable or not, we will let that question rest.

In considering any type of bearing or bearing material we are interested in—

1. Its length of life and consequent effect on frequency of shut down for renewal.
2. Its effect on the product as regards to accuracy of rolling.
3. Its effect on power consumption.
4. Its effect on lubricating costs.

The composition of the material—its melting point—its hardness—its tensile strength—its compressive strength, etc., are only interesting in so far as they affect operation and life. The only good designs are designs that produce results and properly utilize the various characteristics of the material.

Inasmuch as design and application mean everything in effective operation, we shall go over some characteristics of non-metallic bearings which must always be considered in any layout.

Laminated Bakelite is an organic material. It will carbonize and break down on continued exposure to temperatures over 300° Fahrenheit.

Therefore, for satisfactory operation, the temperatures must be kept low.

Second, laminated bakelite is a heat insulator and will not dissipate the heat generated in any fast moving bearing—whether or not it is lubricated properly.

These two characteristics point immediately to artificial and direct water cooling—as being the first requisite of a good installation.

Such direct water spray cooling on the journal not only keeps temperatures in safe ranges, but provides a film between the roll neck and the bearing which seems to have a marked effect on power consumption and bearing life.

Therefore, knowing that to get the best results from laminated bakelite bearings, it is necessary to keep the temperature down and the bearing supplied with direct water lubrication, the type which I am about to describe seems to be the best answer. Instead of making the bearing in one solid piece, it should be divided into several strips, for due to the fact that laminated bakelite is a heat insulator the bearing must be made in several sections and not in a solid segment. The number of strips in the bear-

ing depend entirely upon the size of the bearing itself, and may be two, three, four or more strips. These strips are placed around the neck in a semi-circular fashion with a generous space between each strip. They are as long as the bearing and in one piece if the bearing is 8" or shorter. If the bearing is longer than 8" the strips may be built up satisfactorily from two or more pieces. The material is cut so that the laminations of the sheet are perpendicular to the roll neck itself. This puts the wear on what might be called the end grain and results in much longer life than if the laminations were running parallel with the roll neck.

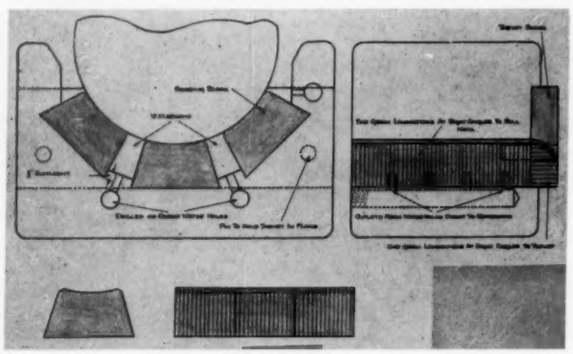


FIG. 1

Figure 1 shows a layout designed to take maximum advantage of water cooling and what might be called "water lubrication". The bearing material is set in the chuck in the form of strips which have been mentioned. The water ways, formed by the space between the strips, provide not only a way for water to get to the roll neck, but also a way for dirt and scale to get out. A good supply of water is the first requirement for long life. In this design, water is not only applied to the bearing on the incoming side, but the chucks are also drilled or cored directly beneath the water way, to supplement the supply. These long holes have outlets spaced along its length so that, including the top sprays, water is applied directly to the roll neck throughout its entire diameter. By applying water generously in these many places, you can readily see that the bearing is kept exceedingly cool and that the roll neck is literally riding on a film of water. As previously mentioned, all scale and dirt is flushed from the bearing, keeping everything perfectly clean.

So much for water. Now, regarding the design of the bearing itself, you will note that there has been some alterations made in a standard chuck. The brass has been removed and a series of dove-tail slots cut into the chuck, the size of these slots varying with the size of the bearing and the number of strips required. Note also that just a small amount of material is required to hold the strips into the chuck generally ⅜" is sufficient. This results in very little waste, exceptionally long life and fewer shut-downs.

Altering a chuck as we have shown here makes the best type of installation. For trial runs it is often possible to install a solid bakelite bearing to replace a standard brass, having slots cut into it for waterways. This type of installation is satisfactory for experimental purposes, but after the strip construction has proven itself, it is better to alter the chuck as shown here on the layout. You can readily see that by removing the brass and setting the blocks deeper in the chuck it is possible for us to use much higher blocks, resulting in more wear and longer life to the bakelite strips. You will note from, Figure 1, the direction in which laminations run in relation to the roll neck itself. We have paid particular attention to this point as we believe it is of the utmost importance as far as bearing life is concerned. The best installations have laminations perpendicular to the longitudinal axis of the roll. This puts all the wear directly on the end grain of the material, which we know is most resistant to wear. There are about fifty pieces of canvas per inch laminated together under approximately 1800 lbs. per square inch hydraulic pressure or if paper base material is used about 100 lb. per inch.

The thrust is more of a problem. The area for distribution of pressure is usually small and the pressures very high. Here again, end grain construction is found superior, and thrusts should be designed in this manner. When possible we make these thrusts nearly as large as the diameter of the roll, giving just as much wearing surface as possible. The thrust is fastened to the chuck in various ways. One method is shown on the chart. This shows pins, brass or bakelite, through the thrusts into the chuck.

There are various other means of fastening the thrust, one being to pin or bolt the thrust directly to the bearing strip, and another being to machine out the chuck and insert part of the thrust into the face of the chuck.

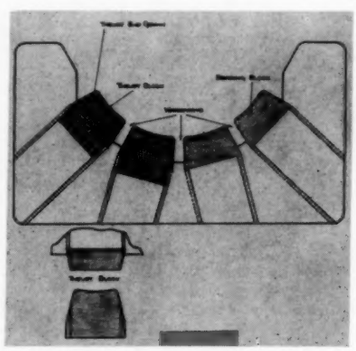


FIG. 2

Another excellent method of designing the thrust for this type of strip construction is as shown on Figure 2. Here you will not that directly in line, and at right angles to the dove-tails which hold the bearing block, there are corresponding dove-tails in the face of the chuck. The thrust is then constructed identically the same as the bearing strips with the exception that instead of the concave surface where the roll neck rides, a flat surface takes the thrust. This is a particularly advantageous design because water plays just as important a part in the thrust bearing as it does on the radial bearing itself. By having the thrust constructed in this manner, we see again the advantage of the water way design which keeps a constant flush and flow of water down through the face of the thrust, keeping the thrust cool, washing away all the dirt and grit and creating a water cushion between the roll neck and the thrust

bearing. This thrust construction necessitates more machine work on the chuck, but is superior to other types and is well worth the time and money spent for changing equipment. These thrusts are very easy to renew by raising the roll, removing the worn thrust and inserting a new piece in its place. This ease of renewal is important as it is generally true that this bearing block construction, due to its long life, will often wear out more than one set of thrust blocks.

While on the thrust question, we must all remember that no thrust ever made will resist very long attacks made with a six foot wrench on the adjusting screw.

In conclusion and summing up what I have already said, remember that this type of bearing is most economical,—First, in initial cost per hour of wear—Second, in savings made by fewer shutdowns for bearing replacements. Third, in saving of time for renewals when necessary, this can be done by raising the rolls. Fourth, savings made in lubrication and power costs. All these points result in more tons per dollar.

The Steel Industry and Its Future

By CHARLES M. SCHWAB,
Chairman, Bethlehem Steel Corporation,
New York, N. Y.

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Presented before the American Iron and Steel Institute May 25, 1933

We meet this morning to appraise our industry in its relation to the swift moving currents of economic rehabilitation.

I am happy to say that the outlook at our meeting today is vastly improved over the situation which existed when we gathered here a year ago. Then we were on the down-grade. Today, with the pick-up of the past few weeks, we are on the up-grade.

Our industry has endured the worst year in its recent history, and relatively speaking its worst year in all time. The fact that most of our companies are still intact, despite huge losses, is a tribute to the sagacity and flexibility of you men who are on the firing line. It has taken brains and courage to carry on for months under conditions of a 15% operation.

Steel Output Doubled

I feel better about our situation today than I have for many months. The improvement which has come about in the past few weeks has given us all new hope. Current operations of 30% to 35% are still far from what we would like to see; nevertheless, this is more than double the 15% rate which existed a few weeks ago and the important thing is that the trend is in the right direction. Before commenting briefly on some of the things that our steel industry is doing in the forward march of events, I would like to point to one or two phases of the world situation which are reassuring.

I have spoken several times in recent years of the effect of the world situation on our national prosperity. It is a thing that we easily forget, but it affects us nevertheless. Our start toward recovery in 1931 was checked by the financial break-down in Europe. Last spring we were greatly harassed by distress-selling of European products on these shores, and that factor is still disturbing.

Aids to World Trade Promising

It is gratifying to see that our administration in Washington is proceeding along lines which should prove helpful toward the international condition. The visits of Messrs. MacDonald, Herriot and others to this country are a helpful sign, especially as these preliminaries are to be followed by a World Economic Conference.

On March 4th this nation was in a state of chaos. This was followed by a program of action more vigorous and more effective than any other we have witnessed in modern times. The President had the courage to take steps in the direction of balancing the budget and to make certain other forceful moves which were necessary to rehabilitate our economic structure. That restored faith throughout our entire nation, and faith in turn has had its far-reaching influence on our financial situation. This has led to an improvement of the credit structure, which is the basis of increases in industrial and commercial activity.

Believes President Will Use Powers Sanely

I consider it a tribute to our democratic form of Government that it has been flexible enough to meet the situation in a critical hour, and I am fully confident that President Roosevelt will use his vast powers sanely and constructively, probably never employing them to the full, and relaxing them as rapidly as the situation will permit.

Business cannot shirk its responsibilities in this situation. As Chairman of this Institute I am glad to be able to say that we were never in a better position to do our part. Since our last meeting we have had the good fortune to have The Honorable Robert P. Lamont, former Secretary of Commerce, assume the Presidency of our Institute, and he will speak to you shortly about the progress of our work which is now under way. The Institute's organization and program have been greatly strengthened. Furthermore, under our new set-up, there is an Executive Committee comprised of steel executives who are lending continuous close counsel in the conduct of its various activities. This should be most helpful in promoting and maintaining the stability of our industry.

Industry Must Regulate Self

I ask the most earnest co-operation of our members in the work of our association, because trade institutions today are being looked to as the spokesmen of their respective industries. Industry must regulate itself wisely and for the public good, if it is to escape regulation from without.

I have said many times that the individual success of our companies is in the end proportionate to our ability to co-operate for the general good. As never before in our business, this belief is about to be put to the test.

Hails Roosevelt Partnership Plan

President Roosevelt in his splendid address to the country on May 7th invited industry into partnership with the Government to solve its problems. This open-minded pronouncement warrants the admiration of the entire country. I am happy indeed to express mine. The President offers to the business world the facilities and prestige of our Government in eliminating unfair competitive practices with all of their ruinous effects upon prices, wages and profits. In my judgment it would be most unfortunate—indeed it would be a calamity—for business and employment in this country, if anything were done by legislative fiat to interfere with an orderly and sound restoration of employment. It is, therefore, encouraging to note the President's rejection of governmental control and the substitution of the more effective proposal of a governmental partnership. We have had quite enough of restricted production, hours of work and wages during the past three years. What we need now is greater production, more hours of work and expanded income for our employees.

Moreover, we need price stability. The President will have strong support for his plan to assist the nation's business machine through the easing of laws that are unduly restrictive and through substitution of co-operation instead of ruinous trade practices and price cutting. Speaking for the steel industry, I say that we gladly accept this offer of partnership, because with this kind of support and through our revitalized Institute we should speedily and effectively be able to see brought into line those selfish interests who persist in unfair practices that are contrary to sound public policy and ruinous to industry.

Sound Profits Basis of Prosperity for All

As I see it, we as an industry can make no greater contribution to the country's total economic well-being than to return our individual companies to a profit basis as quickly as possible. This will not only give us courage to proceed with needed rehabilitation and other deferred plans; but, more important still, it will arrest the downward trend of our employees' purchasing power.

This progress toward profit-making is already under way. Our steel production for the year 1932 of less than 15,000,000 tons descended to levels which even the worst of pessimists would not have predicted two years ago. It is small wonder that the industry sustained a loss of approximately $161,000,000 under such circumstances. Now we are steadily emerging from that deep water. Our feet are on rock. In view of the short time in which we have had this improvement, I feel it is too early to forecast ingot production for this year. But it is safe to say that it will be an improvement over last year and there is every indication that we shall look back on 1932 as a record low.

Would Scrap Obsolete Plants

We have had three years of facing stern facts, and we can profit by continuing to be realistic. Let us see straight on our manufacturing set-up. If all the obsolete or semi-obsolete plant equipment were eliminated, that would go far toward strengthening our whole situation. I dare say, if it were possible to appraise fully the struggle to justify obsolete plants, we would find that much of the uneconomic disturbance in American manufacturing today is due to attempts to make "dead horses" pay. It takes courage to scrap a huge investment. We need not feel, however, that in so doing we are admitting a mistake in the past. We are in fact recognizing that conditions have changed and that we are reconstructing our set-up in line with modern demands.

Our steel picture is very materially changing. In the year just prior to and immediately following the war, the steel industry was manufacturing primarily for capital goods,—plants, huge buildings, and heavy-production equipment. This will always be a substantial back-log, but its dominance will be less marked. An increasingly important part of our business in the next few years will be in consumer's goods The public for three years has been doing without thousands of items which enter into our normal standard of living. There is a three-year lag of automobile consumption to be made up. Progress in home-building has lagged for even a longer period. The use of steel in many directions has been arrested in its momentum by the hard times.

Consumers' Goods to Revive Steel

This emphasis on consumers' goods, with particular demand for quality tonnages, bears out a prediction which I made two years ago that we may see the day when value comparisons may become more and more a measure of our business. It seems quite possible that we may return to the profit-making days of prosperous years without equaling them in tonnage because of the lighter, higher quality steels which are currently in demand.

Predicts More Advertising

I shall leave the subject of marketing to the speakers in that field, but I must observe that the new emphasis on consumers' goods must bring about changes in our methods of selling. There will be more intelligent and more extensive advertising, closer analysis of markets, and a more thoughtful study of extended uses for steel.

I return now to the advances which the steel industry has made in the field of human relationships. The old-fashioned policy of every man for himself and the devil take the hindmost was abandoned by the steel industry many years ago. Our industry throughout this depression has done its utmost to protect the financial status of its workers. I believe that the splendid loyalty of our employees, and the absence of labor troubles throughout these hard

times, has been due to a recognition by the employees that management has been doing its utmost in a dire situation.

Long Record of Employee Benefits

We maintained the rate of wages as long as was feasible, maintained it until there were very considerable declines in the cost of living. Our industry was in the fore-front in the distribution of work, before the formal organization of the Share-the-Work Movement, and we co-operated to the fullest extent with that movement when it was put into effect nationally. By the adoption of distributed work the steel industry has been able to carry on its rolls approximately 200,000 more employees than would be needed if we had followed the policy of working those whom we retained on a full-time basis. The average working time in the steel plants has been less than thirty hours per week per man, which indicates the extent to which we have adopted the work-sharing principle.

The steel industry has done its part and I believe that this will be fully recognized when the history of these times is written. I could read an honor roll of the companies in the steel industry who have done many things for the protection of their employees, and that roll would include virtually every name in our membership. I could cite a score of instances of company-wide relief plans, employee garden projects, rent concessions, pensions, sickness benefits, all carried on voluntarily and in direct co-operation with representatives of our employees and aggregating many millions of dollars.

I am well aware that the unemployment situation continues to be grave in this country, and that work-sharing is not the whole solution. Part-time incomes are not sufficient for meeting the high standard of living which we have achieved in this country, and which our people will not and should not forego.

Workers' Earnings Improving

As revival has taken place and our production has increased, however, employees who have been working on meager part-time schedules for many months have gotten more employment and better income. This is healthy—the back-bone of this depression will have been broken when we can restore our workers to more nearly normal working time, and it is volume—an increase in manufacturing activity—that will do this.

Sees Wide Spread of Prosperity

Moreover, with a return of prosperity for the people as a whole, I believe that we will see an orderly and effective correction of present unemployment. In our own industry, given a reasonable demand for our products, we will again absorb our quota of the nation's wage earners affording, as heretofore, employment on reasonable standards of hours and at good wages. The relations between our employees and management are in splendid shape. Our industry has had a long record of paying good wages, affording our employees their fair share of our economic prosperity; as well as enhancing the purchasing power of the public and the ultimate stability of American business. The Institute has a responsibility to see that we so conduct our businesses that we may continue to be in the forefront of whatever movements may be necessary for social progress.

We must not neglect this duty. I have cited the splendid work which the steel industry has done in relieving distress among its employees during this depression. Splendid as this has been, however, it is only fair to say that the industry in the main was not prepared to meet the situation as adequately as would have been the case if reserve funds for unemployment had been built up in times of prosperity. As we emerge from the depths of this depression, industry should profit by the experience of the last three years and voluntarily, both as a matter of social justice and sound business, work out with its employees and put into effect plans of unemployment reserves to help meet any future depression.

Legislation should not be required to do this job any more than it has been necessary to assure the introduction of pension and other relief plans. If legislation proves necessary in specific instances, it should be so drawn as not to affect or impair voluntary activity by forward-looking industries. Otherwise, years of progress and voluntary action would be endangered.

Calls on Steel Industry to Set Up Unemployment Reserves

We can work out voluntarily in this industry a method of providing reserves commonly called "unemployment insurance" that in the end will be of greater benefit to our employees and society in general than any inflexible compulsory plan which might be forced upon us. I, therefore, recommend that the membership of this Institute give consideration at the earliest possible opportunity to the formulation and adoption of adequate unemployment reserve plans for the protection of their employees in future periods of business recessions.

Now for a final word. As a veteran in this business I cannot close these remarks without a word of congratulation to you who are carrying the industry through these difficult times. You boys must feel as though you have been through a continuous mill. You have been rolled, flattened and crimped by the past three years; but the original heat was all right, and you have passed through the testing room with flying colors.

The steel industry by its very nature is a peculiarly difficult business for swift adjustments. A steel company cannot get its supplies on the spur of the moment, build or tear down its equipment within a few weeks. It must have large supplies of raw materials and enormous investments in plants covering wide areas. Such an institution must be built in such proportions during active times, involving an overhead of fixed charges and taxes, which prove extremely burdensome in periods of low operations. The managements of the companies in the steel business have made short-cuts, taken enormous decreases in income, have bought shrewdly and have operated the plants with maximum consideration for the welfare of the stockholders, the employees and the public. If our fixed charges have made it impossible to earn a profit, we have nevertheless kept our financial structure in reasonably sound condition.

Management in Step with Changed Conditions

We have kept the real property of our corporations, namely the plants and other facilities, in proper condition where they will be usable to the fullest extent as soon as conditions warrant. In view of the times we have been passing through, I believe we may feel that the management in the steel industry has accomplished a tremendous task in essentially maintaining the status of the various corporate units.

Our eyes are now lifed to the future. The present upturn has done wonders in instilling hope in the hearts of everyone. As Chairman of this Institute, I say that the men of this great industry will tackle the problems ahead with characteristic vigor and enthusiasm. We shall play our part in restoring stability to a recovering world. We have been through some trying times, to be sure, but they have not dimmed our optimism. I would remind you, as I have before, that after each set-back in the past we have advanced to greater heights. We are ready to go onward and forward with faith in the future of our industry and our country.

The National Industrial Recovery Bill

By HON. ROBERT P. LAMONT,
President of The American Iron & Steel Institute

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Presented before the American Iron and Steel Institute May 25, 1933

The National Industrial Recovery Bill now pending in Congress is an effort on the part of the Administration to start this country out of the depression by spreading work and increasing buying power. To accomplish this, it is declared that a national emergency exists and it is to be the policy of Congress, under its powers to regulate interstate commerce, to promote the organization of industry for the purpose of co-operative action among trade groups, to induce and maintain united action of labor and management under adequate governmental sanctions and supervision, to eliminate unfair competitive practice, to reduce and relieve unemployment, to improve standards of labor, and otherwise to rehabilitate industry and to conserve national resources.

The weaknesses of our present industrial system are naturally exaggerated in times of depression. We are all aware of the evils that have grown up under the present competitive system. We cannot overlook the fact that a minority in almost every industry has been guilty of unfair competitive practices which have tended to weaken confidence and morale and destroy the high standards which the majority would like to maintain.

An important feature in the proposed law is that which, under certain conditions, exempts industry from the antitrust laws of the United States. This is the result of the insistence of many business men and organized business groups upon such modification. It has been thought by many that business could be managed to better advantage if competitors could get together without violation of law and control production and prices and other competitive practices, and perhaps it is fortunate that we are to have an opportunity to experiment with a measure of freedom from the restraints of the antitrust laws, combined with more supervision and regulation by government than we have been accustomed to. We may be able to judge the results before the change is made by a permanent policy of government.

The bill gives the President almost unlimited powers to carry out its provisions. He may employ the necessary staff, establish administrative agencies to aid in enforcing the bill, and may delegate his own powers to other individuals. The President, also, has the authority to approve or reject codes of fair competition submitted to him by organized industrial groups, or to modify these codes so as to effectuate the policy of this bill. Industries which do not voluntarily adopt codes may be compelled to bring their competitive practices in accord with regulations which the President may establish. His powers also permit him to approve of agreements among business groups and labor organizations, and in enforcing the provisions of the bill, he may require industries to operate under federal licenses which may be revoked for violation of the provisions of the measure. In those industries which are unable or unwilling to enter into agreements with labor regarding wages, hours of labor and working conditions, the President is empowered to establish and prescribe such standards.

The normal procedure contemplated by the bill is that trade and industrial associations or groups in the various industries should agree upon a code of fair competition which will be submitted to the President for his approval. If the President finds that such associations are truly representative of their industry, and impose no inequitable restrictions on membership, and that the proposed code is not designed to promote monopoly or to eliminate or oppress or discriminate against small enterprises, he may approve the proposed code. As a condition of his approval, the President may require the making of reports and keeping of accounts, or may impose other conditions for the protection of consumers, competitors, and employees. He may also make exceptions and exemptions from the code.

After the President approves a code, it then becomes a standard of fair competition for the industry, binding not only upon those who belong to the trade organization and have agreed to the code, but also upon all others engaged in that trade or industry. Any violation will be considered an unfair method of competition, subject to the jurisdiction of the United States District Courts, and punishable by fine.

Section 7 of the Bill is one that will cause a good deal of concern and will be subject to various inter-

pretations. Amendments to this section have already been proposed by the American Federation of Labor. This section specifies three mandatory provisions which must be included in any code of fair competition to be approved by the President. They are, **first,** that employees shall have the right to organize and bargain collectively through representatives of their own choosing; **second,** that no employee, and no one seeking employment, shall be required as a condition of employment, to join any organization or refrain from joining a labor organization of his own choosing; and, **third,** that employers shall comply with the maximum hours of labor, minimum rates of pay and other working conditions approved or prescribed by the President.

"(b) The President shall, so far as practicable, afford every opportunity to employers and employees in any trade or industry or subdivision thereof with respect to which the conditions referred to in clauses (1) and (2) of subsection (a) prevail, to establish by mutual agreement, the standards as to the maximum hours of labor, minimum rates of pay, and such other working conditions as may be necessary in such trade or industry or subdivision thereof to effectuate the policy of this title; and the standards established in such agreements, when approved by the President, shall have the same effect as a code of fair competition, approved by the President under subsection (a) of section 3."

Many of the individual plants of the iron and steel industry have had in operation for many years machinery whereby the employer and his employees mutually discuss and decide questions of wages, hours and other matters of common interest. This method, which has proven its adequacy and effectiveness in maintaining satisfactory labor conditions in the past, can be expected to provide the means for complying with this provision of the bill.

If the employers and employees of any industry are unable to reach a satisfactory agreement, the President is authorized to investigate conditions in that industry and to prescribe maximum hours of labor, minimum rates of pay and other working conditions which shall be binding upon all members of the industry, or subdivision thereof. The bill does not require that minimum rates of pay established by mutual agreement between employers and employees, or prescribed by the President, shall be uniform for all classes of employees, or for all localities. In fact, it is clear that the minimum wage will vary according to the experience and skill of employees affected, and according to the locality of employment. The provisions of the bill forbid the establishment of maximum rates.

There is one serious omission in the bill to which, I think, I should call your attention. It is obvious, of course, that the operation of the bill, the purpose of which is to shorten work hours and maintain fair wages and prices, will tend to increase costs and selling prices and thus make this market a still more attractive field than it now is for foreign goods. There is no provision now in the bill to offset this competition, but an amendment, which has been drawn, will do so if it is adopted. The tariff truce until after the adjournment of the World Economic Conference is a serious difficulty but may not be insurmountable.

The second part of the bill creates a federal emergency administration of public works and provides for a comprehensive construction program to be undertaken under its guidance. Inasmuch as many of these projects will require the use of considerable tonnages of steel, this program is of obvious interest to our industry.

It is with the industrial features of the bill, however, that we are more immediately concerned. The success of this plan in accomplishing its stated purpose will be determined almost entirely by the character of its administration and by the spirit and manner in which industry itself carries out the provisions of the law. The bill possesses such vast potentialities for good or evil, such great possibilities of success or failure in attempting self-government in industry, that it challenges all our practical experience and intelligence. The lip service which we have been so ready to render to the ideal of co-operation and the maintenance of ethical standards will now be supplemented by a very real co-operation and standards enforced by law. The selfish and often ruthless minority will now be compelled to conform to a code of fair and ethical practices which makes the welfare of the entire industry, and of the nation, its chief concern.

Moderation, restraint, fair play will be just as necessary in operating under this law as under existing competitive conditions. The conduct of business will not be any easier; indeed, it may be much more difficult than under the highly individualistic, independent conditions we have been accustomed to for many years.

Your Executive Committee is carefully studying this new plan which the President has described as a partnership between government and industry; ALL members of the industry should give it careful consideration and submit any suggestions or reservations which you have in mind regarding a code of fair competition for the steel industry. If the bill is passed by Congress in such form that the industry of the country generally finds it practicable and workable, your officers will no doubt be instructed to prepare such a code and your suggestions will receive careful consideration.

Obviously, decision on the many questions of policy involved is especially difficult in an industry which is as complex and widely distributed geographically as the steel industry. There have always been variations in prices, wages and working conditions in the various steel producing centers and in the many branches of the industry. Some members of the industry produce practically every item of iron and steel and by-products; some specialize in a few items; there are differences in location with respect to supplies of raw materials, in types of transportation, in markets and in methods of distribution.

I am sure that the members of the steel industry are fully in sympathy with the purposes of the proposed bill. Within the limits of their ability to do so they are anxious to co-operate in any sound plan to revive business and increase employment.

The Use of Rolled Steel in Machine Construction

By H. G. MARSH,
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Presented before the American Iron and Steel Institute May 25, 1933

A striking change has come over the modern machine shop. Scattered throughout are numerous lights; some are bluish, sputtering ones of great intensity with hooded, ghoulish figures attending them —others are bright yellow, throwing off at times showers of sparks.

These lights mark a new era in machine construction, for two new fabricating processes have been introduced into this industry—flame-cutting and welding. These processes have in turn introduced a new type of construction and a new material, rolled steel.

It is not the purpose of this paper to deal technically with these processes as each is a subject in itself, but a review or summary of their latest developments is necessary to properly appreciate the examples of this type of construction which will be presented later.

PROCESSES—Flame Cutting

Flame cutting by the oxy-acetylene or some equivalent process is a far-reaching development in the field of machine construction and it particularly is responsible for the entrance of rolled steel into this market.

Before this process was perfected, the only method of cutting steel was by shearing or machining. Shearing was limited to thicknesses of about ¾ inch to 1 inch where reasonably good edges were required and machining was very expensive. If the contour was irregular, the cost of machining was almost prohibitive.

By flame cutting practically all thicknesses of metal can be cut and with reasonable accuracy. The accuracy depends on the thickness of the metal. For 2-inch plates the cutting tolerance can be held to plus or minus 1/32 inch to 1/16 inch and for plates or slabs 24 inches thick, plus or minus 3/16 inch. The squareness and finish of such cuts are comparable with rough machining and are being accepted as satisfactory surfaces for many machine parts without further machining.

Practically all steels used in machine construction can be flame cut without injury to the physical qualities of the metal, but in the higher carbon steels they are preheated before cutting and normalized after cutting.

Automatic machines are available for straight and circular cutting and pantographs for irregular shapes. From the examples of the skill developed by workmen using these devices, their possibilities seem unlimited.

Welding

In speaking of welding, the term will refer to "fusion" welding, either gas-torch or electric arc, as these methods are the ones commonly used in machine construction. Torch welding is usually used in fabricating thin sheets, although its use is not confined to this field. Electric arc welding is used extensively in all kinds of machine construction.

Almost all metals can be welded but we are concerned only with steel in the forms in which it is used in this field of application. Low carbon steel is welded with little or no trouble, but as we approach the higher carbon ranges the difficulties increase. Alloy steels must be considered from a viewpoint of the alloys involved, and while they can be successfully welded, each presents a problem of its own. Cast steel is welded satisfactorily without difficulty, which is not the case with cast iron.

In fusion welding, molten metal is deposited and fused with a parent metal. The composition of the added metal, the conditions under which it is fused and the treatment it receives in cooling determine the physical characteristics and strength of the joint. These factors are controlled to a great degree by the welding procedure and the kind of material used, but with good practice today, the weld metal as deposited has a tensile strength of approximately 65,000 lbs. per sq. in., a ductility corresponding to a 30% elongation in 2 in. and a fatigue limit of 24,000 lbs. per sq. in. Also, and this is important to note, there need be NO zone or plane from parent metal, through the weld metal and back to the parent metal again, which is not substantially equal to the parent metal itself if the proper procedure and proper materials are used.

Speeds and costs of welding have no place for discussion here as they are dependent upon many variables, but with the development of coated rods and automatic welding machines such figures are changing daily and it requires very little imagination to multiply or divide them by ten for the near future, in which case it is impossible to visualize the extent of the application of this construction.

COMPARISON OF MATERIALS

In mentioning rolled steel in a preceding paragraph as a new material for machine construction it was done with a full knowledge that it has been used to some extent for this purpose for a number of years, but its use has been restricted by the fact it could not be readily cut into irregular shapes and the only methods of fabricating were riveting and bolting. During this period its use was confined largely to frames for conveyors and roller tables, cover plates and small parts of rather minor importance. Irregular shapes and parts of complex construction required that the part be cast. The development of flame-cutting and welding now enables us

to produce in rolled steel practically any machine part regardless of its size and shape or complexity.

In taking its place in this field rolled steel is, of course, replacing castings; cast iron principally but cast steel also to a great extent. This is due to certain physical advantages it possesses and to advantages gained through the new method of fabricating.

The most important physical property of a material for machine construction is a high modulus of elasticity, or in other words a high resistance to deformation. In this respect rolled steel is the best material available for the purpose, as it has a modulus of elasticity of about thirty million pounds per square inch as compared with only twelve million pounds for cast iron. This means that cast iron will stretch two and one-half times as much as steel under similar loading.

Compared with cast iron, simply as a material for machine construction, steel has many advantages besides strength to recommend it. It is much more homogeneous, its physical properties are more readily determined and for all practical purposes are constant. It has sufficient ductility and can be bent or formed within reasonable limits without material injury to its physical properties. It is also free from brittleness in the grades commonly used for this purpose and has a great resistance to fatigue. Cast iron is much inferior in these qualities and the forms in which it is produced also tend to cause undue concentrations of stress which reduce its value in service.

Compared with cast steel as a material for machine construction, the superiority of rolled steel is not so marked. In physical properties there is little difference in well-chosen test pieces but in actual practice rolled steel is much more reliable, as there is not the same danger of blow holes, segregation, undesirable grain structure and internal strains from shrinkage. Another advantage of rolled steel is that it is obtainable in a great variety of grades with a wide option as to the physical properties, and as practically all grades of steel can be welded, this enables the designer to provide for highly stressed members, wearing surfaces and other special conditions in one unit.

WELDED STEEL CONSTRUCTION

Material

The material to be used and the process by which the material is to be fabricated determine many of the important factors in the design of machinery. They also affect the style or appearance of the structure.

A mechanical artist now has a new medium and in order to obtain the best results he must study it thoroughly, just as any other artist must study a new medium. It means a thorough grounding in fundamentals and much practice on simple problems before the more complicated ones can be mastered. It is just as inconceivable that an accomplished painter can master the intricacies of etching without months of heart-breaking failures as that a machine designer steeped in foundry tradition can master the art of welded design without a corresponding period of grief. Consultation with an expert in this line is advised.

The first difficulty he encounters is the lack of limitations, or rather the greater amount of freedom and flexibility this new medium permits. The tendency is to weld, weld, weld! This is costly and unnecessary and the designer will soon learn to so choose his material that it will require a minimum of welding. In many cases the best welded design is the one with the least amount of welding.

The choice of material is of utmost importance. There are available a great number of rolled sections and a thorough knowledge of them is indispensable.

They include billets, slabs, plates, structural shapes in various forms, bars of all descriptions, pipe, forgings, steel castings and specially rolled sections, which can all be incorporated into the design. There is a great difference in the price per pound of these products and many of them can be had in various grades of steel, so with the wide choice of materials and their varying costs, besides the actual welding, it is not a simple problem to work out the most efficient and economical design for a given job.

Generally speaking, rolled sections are the most economical. Formed sections come next, followed by welded ones. In other words, a rolled channel is cheaper than one formed from a plate, and one formed from a plate is cheaper than one welded from three flat steel members. On the other hand, while a rolled I-beam is cheaper than a welded one, if the beam is to be curved rather than straight, the welded one, flame-cut from a plate, might be more economical.

Forgings are usually much higher in cost than rolled steel on a per pound basis, but in many cases they can be used to advantage. Irregular shapes, flame-cut from billets or slabs, can often be used in place of forgings. There are so many factors usually involved in such cases that each job is a problem in itself.

Special shapes are also high in cost, but if the job warrants, they are available, and if sufficient tonnage is involved, the roll cost can be absorbed by the steel manufacturer by a special arrangement. The field for such material is naturally for machine parts built in great numbers. While special sections have not been used to any great extent up to the present time, they present possibilities for the future and the inquiries received indicate that engineers are thinking along such lines.

For most work the ordinary shape book or warehouse stock list will furnish all the information necessary on shapes, plates and bars, but for heavier construction, where the limits of the mills are reached, the question of material should be taken up with the manufacturer, as there are many factors involved which should be the subject of negotiation. In rolled plates reasonable limits, which are perhaps representative of the industry, are 146 inches wide, 15 inches thick, with a weight limit of 30,000 pounds. For forged plates a common width limit is 150 inches and the weight limit 150,000 pounds. The thickness will sometimes depend upon the amount of reduction necessary. Experience indicates that these limits will furnish material for practically all machine construction.

In submitting inquiries to the steel manufacturers for material for welded construction it is of utmost importance that sufficient information be given them. Surface requirements, flatness, size tolerances and

quality all enter into the question of price, and the more that is known about these things the more intelligently the inquiry can be handled. Otherwise the manufacturer might quote on a highly finished plate rolled closely to size and carefully flattened for a part that is to be machined all over and could very well be made from a billet or slab, which would naturally take a very much lower price. Where the material is to be flame-cut at the mill it is also important that full information be given. A complete, detailed drawing of the part showing the proposed machining is desirable.

While there is a great variety of material available, the designer will do well to confine himself to the fewest number of shapes and sizes, as some of the published shapes are not always quickly available. The fewest number of shapes and sizes should serve the greatest number of uses.

Design

A most important thing for the designer when first taking up welded construction is to clear his mind of the restrictions imposed upon design by cast construction, such as patterns, shrinkage, flow of metal, etc., as it is desirable if the best results are to be obtained to take full advantage of the superior qualities of rolled steel. Replacing cast iron or cast steel with rolled steel, part for part, section for section, results in nothing gainful. It is true something might be saved in weight but it would probably be at the expense of stiffness. It is also likely such a structure would cost more than the casting, due to the excessive amount of welding required. The greatest objection, however, is that the design which may have been an excellent one for cast construction is carried out in a material to which it is not suited, and all the advantages to be gained from the use of the better material are lost.

The best way is to start anew with a careful analysis of the function of the machine and its component parts. The direction and magnitude of the stresses involved should be calculated as closely as possible, their relation to each other studied, and then the best adapted rolled steel sections should be selected and combined in the simplest possible way.

A fine example of this is the welded steel mill housing. The essential element in a mill housing is a closure, which will confine the rolls to vertical alignment and permit of vertical adjustment and vertical pressure. Obviously, a rectangular closure would be a poor one from a standpoint of stresses, so by rounding the ends we have an elongated link and by inserting a screw jack between the rolls and the inside top of the link it fulfills all the requirements of a housing. All that is now necessary is to provide feet which will assure its maintaining a vertical position. If the designer had attempted to reproduce a conventional housing in welded steel with all its irregularities of contour and section, the result would have been entirely different and perhaps not practical from a cost standpoint.

This job is also an example of the help the steelmaker can give the designer if he is acquainted with all the factors involved. The housing was originally designed for plates 2 inches thick, but on account of the great percentage of scrap and excessive machining, it was suggested it be made of thick forgings, in which case an allowance based on the price of slabs could be made on the material cut from the center. This center piece amounted to 46% of the weight of the rectangular slab, from which it was cut, and the allowance, which was a perfectly legitimate one, made the design commercially possible.

A designer will soon find that certain devices are now feasible which were practically impossible in cast construction. One of these is the box section, which has excellent resistance, not only to tension, compression and bending stresses, but also to torsional stresses. Rigidity is most essential in machine construction, and as stresses are frequently very complicated and very difficult of analysis, such a section enables him to obtain the required resistance to deflection without resorting to excessive weight.

The design and placing of welds is extremely important. Welds are joints, and any form of joint involves a local concentration of stress. While weld metal is comparable with the parent metal in modern welding, the joint should not be unnecessarily subjected to frequently reversing stresses, shocks or repeated overloads of great intensity. A welded joint whose length is parallel to the direction of stress resists impact much better than one at right angles. A little ingenuity and forethought will usually enable the designer to place welds in favorable, rather than unfavorable, positions.

It is also desirable for the designer, who is familiar with all the conditions and requirements of the structure, to determine the welding procedure and so designate it that there will be little left for the welder but to follow instructions. Procedure is just as important in welding as in any other shop process and as long as drawings go to the shop simply marked "weld here" we will have weld failures.

Welding, regardless of the method employed, requires heat and although this heat is localized, it sets up stresses which must be relieved. This fact should be ever present in the mind of the designer and also the welder, as it is possible through the proper design and welding procedure to keep these stresses down to a minimum. Such stresses as remain are relieved by two methods—the first by peening the weld layers thoroughly during the welding process and the second is by annealing the structure when partially or wholly finished. The method of stress-relieving will largely depend upon the type and size of the structure.

Waste in flame-cutting irregular shapes is a problem which common sense should solve. Material should be ordered and designs made with a view to using up as much of the stock purchased as possible. Only one suggestion can be offered which might help, and that is to have the flame-cutting done by the steel manufacturer at the mill where there is only a slight probability of the purchaser using the discard. In this way an allowance is obtained on the scrap, the freight is saved, as well as the cost of later cutting it up into charging box size.

In suggesting the designer should forget certain things regarding castings and foundry practice, it was not meant he should entirely forget the foundry's existence. The foundry has its place in the picture, for certain parts can be made cheaper of cast steel than rolled steel. The ideal construction will always

be the one which is most economical and still fulfills all the requirements. No objection can be made to a combination of cast steel and rolled steel and the beauty of this fabricating process is that they can be welded together without difficulty.

Some electric motors are made with one bearing pillar of cast iron and the other of welded steel, in which case cost is no doubt the deciding factor.

Bearings on welded steel gear cases are usually made cheaper of cast steel because they are simple, inexpensive castings, while a similar part of rolled steel means a forging or a difficult flame-cutting job. If made of cast steel they are welded onto the rolled steel case with the same facility as the forging or flame-cut part.

Very often small bearings and other parts can be so designed that they can be used in a number of places, which distributes the pattern cost and brings the unit cost of the casting below that of a welded steel part.

Great strides have been made in stress analysis through the study of small scale models with the aid of the photo-elastic ray and other devices. These studies have enabled engineers to locate and to some extent measure stress concentrations. They are now avoided rather than overcome by simply adding more metal at these points, and the trend is toward simplified design wherever possible. Welded construction lends itself admirably to this movement, for as design becomes more refined and exact, it becomes increasingly important to use a material the strength of which is known within very close limits. Frequently, castings which have failed in service have been re-designed and built of rolled steel and through refinement of design the weight has been materially reduced, while the strength of the part increased.

The advantages of welded rolled steel construction may be summed up as follows:

Weight

Due to its strength and reliability, welded steel construction can frequently be made less than half as heavy as an equivalent construction of cast iron. This is particularly true of parts subjected to tension, bending or torsional stresses.

Considerable saving in weight is also shown over cast steel construction. This is due not only to the reliability of the material, its definite physical qualities and the absence of defects but also to the more economical placement of material, for the flow of metal is no longer a dimensional factor in the design of the various parts.

This saving in weight is reflected not only in the first cost of the machine but also in transportation charges and frequently in the construction and cost of supporting structures.

Cost

The subject of cost is a difficult one. Generally speaking, if only a few parts are to be made, rolled steel is unquestionably cheaper providing the parts or units are not exceptionally intricate ones, which require an excessive amount of welding or waste of material. If a great number of parts are made, the original pattern expense is soon dissipated and a casting may be cheaper. In production work, tools and jigs for welding are also cost factors which must be considered.

Such parts as machine bases and bed plates are almost always cheaper in rolled steel on account of the relatively small amount of welding and fitting for the weight involved. They are usually made of rolled sections cut to length and fitted with very little labor or waste of material. There is usually a greater saving in replacing cast iron than cast steel.

A very important item of expense where castings are used is a loss occurring when defects are uncovered by machining. This usually necessitates the scrapping of the piece with the attendant loss of time and labor already expended. Any defects that might occur in rolled steel are usually uncovered during manufacture at the mill, and thus do not entail a loss to the machine maker.

Inventory

The stock of cast parts which a manufacturer must carry to insure steady operation of his plant is an important item of expense. An ample supply of some parts must be kept on hand and patterns for others stored and kept in good order. This adds considerably to the costs.

With welded construction, a relatively small stock will suffice, particularly if care has been exercised in the design so that one size of plate or one section is used for as many parts as possible. The excellent warehouse facilities throughout the country can also be used for urgent needs for unusual sizes.

Many rolling mills are taking an inventory of the patterns carried and where the part can easily be made of welded steel construction, a drawing is made and the pattern scrapped. When the part is needed it can usually be built as quickly as the pattern can be conditioned and a casting procured.

Obsolescence

For a manufacturer to keep his product up to date and competitive requires constant changes in design. Many times such changes are not made because of the expense involved in scrapping a stock of cast parts and making new patterns. If built of rolled steel it is frequently possible to change a part entirely and still make it from the same stock. Minor changes seldom present any difficulties and even the jigs and fixtures can be modified with little expense if they also are made of the same construction.

This feature is particularly important in this day when machines are continually becoming more specialized and improvements are being developed with great frequency. It enables a manufacturer to adapt a standard machine to unusual conditions at very little expense.

Deliveries

For machines manufactured in quantities, labor costs and machining time depend on the details of the parts involved. Generally, there is less machining with welded construction than with cast construction if the parts are properly designed, and consequently a saving in time is feasible. However, the big saving in the time required in manufacture is in the case of special or new machinery where new pat-

terns must be made and new castings secured. Frequently a rolled part can be flame-cut and welded in less time than required to make the pattern.

In the construction of a large rolling mill, the casting for the housing is usually the last part to be delivered to the machine shop as it requires a long time to make the pattern, prepare the mould, pour the metal and let it cool. It must then be annealed. In the case of the mill mentioned before where the housing was made of welded construction, the first piece to be delivered to the machine shop was the housing and machining started immediately.

Conclusion

Our chief interest in any innovation or new development is its effect upon our own industry. The effect of this new method of construction on the steel industry will be far-reaching.

It will enable us to devise better equipment from a viewpoint of function, service and cost.

A large part of the tonnage now going into castings will be the product of our plate and structural mills. Yesterday we tried to visualize a 15 to 20% conversion; today's indications are that 60% is nearer the correct figure and developments in the near future will possibly force us to again revise our ideas.

Perhaps the most outstanding result of the introduction of this method of construction is the birth of a collateral industrial unit, the "Weldery". Commercial welderies are being established in various districts which will specialize in welded steel construction. Their business will no doubt replace to an appreciable extent that of commercial forge shops and foundries, and from estimates made by those in close touch with this development they offer a potential business of several million tons of rolled steel products annually.

ITEMS OF INTEREST

PERSONNEL CHANGES

Chester McDowell has been appointed superintendent of rolling mills of the Washburn Wire Co., Phillipsdale, R. I. For two and a half years he had been associated with the United Engineering & Foundry Co., Pittsburgh, and prior to that for a period of 14 years he had been connected with the Bourne-Fuller Co., Cleveland, and the Republic Steel Corp., Youngstown, O.

▲

Herbert G. R. Bennett, assistant superintendent of the Youngstown, O., district bar mills of Carnegie Steel Co., Pittsburgh, has been named assistant general superintendent of the Duquesne works.

▲

Frederick L. Pierce has resigned as vice president of the Cutler-Hammer Inc., Milwaukee, manufacturing electric control devices. He has not been active in the business for some time. He remains a member of the board of directors. Henry F. Vogt, treasurer, has been elected vice president, continuing as treasurer.

▲

Mr. W. F. Kurfess, manager of the mill department of Joseph T. Ryerson & Son, Inc., has been appointed assistant vice president of the company.

Mr. M. J. Hartigan succeeds Mr. Kurfess as manager of the mill department.

▲

The Homestead Valve Manufacturing Company, Coraopolis, Pa., have just appointed the following exclusive representatives for the sale of 'Hypressure Jenny', vapor spray machine used for automotive, industrial and building cleaning.

Mine & Smelter Equip. Co., 7th Ave. and Santa Fe Tracks, Phoenix, Arizona. (covering the State of Arizona).

R. S. Armstrong & Bro. Co., 676 Marietta Street, Atlanta, Georgia. (covering the State of Georgia).

Nixon-Hasselle Co., Carter at 13th St., Chattanooga, Tenn. (covering Middle and Eastern Tenn.)

▲

STEEL OFFICIALS HONORED

The Gary Memorial Medal, established by the American Iron and Steel Institute to honor Elbert H. Gary, its Founder and first President, and to perpetuate the memory of his achievements in the iron and steel industry, was this year awarded to Willis L. King, Vice President of the Jones & Laughlin Steel Corporation. In presenting the medal, Chairman Charles M. Schwab announced that it was "for his oustanding achievements as a leader in inspiring high ideals and promoting confidence and good will in the welfare of the iron and steel industry."

Mr. Schwab also presented the American Iron and Steel Institute Medal to Clarence B. Randall, Vice President of the Inland Steel Corporation, Chicago, Ill.

▲

OBITUARIES

Harry Hudson Cutler, founder of the Cutler-Hammer Co., Milwaukee, and widely known inventor in the electrical control industry, died May 21, at Miami, Fla. He was born in Boston and established the Cutler-Hammer business in Chicago in 1893. Several years later it was merged with the American Rheostat Co. of Milwaukee, and the plant was moved to Milwaukee. Mr. Cutler retired in 1917 and returned to Boston to continue his research and inventions. During his active career he was granted 76 letters patent.

▲

Mr. Leon H. Frank, vice president of Bull Dog Electric Products Co., Detroit, Michigan, died at Charleston, S. C. on Sunday, May 28th.

Mr. Frank was motoring back to Detroit with his family, after having spent the winter in Florida. Arriving at Charleston, Saturday, May 27th, he complained of illness, was removed to a sanitarium and passed away early the following morning.

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OIL TIGHT
DUST TIGHT
ANGULAR
AND OFFSET
MISALIGNMENT
FREE END FLOAT

NO SPRINGS
NO PINS
NO BUSHINGS
NO RUBBER OR ANY
KIND OF FLEXING
MATERIALS

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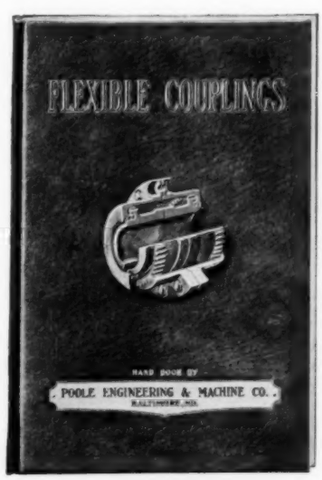

Our handbook

"FLEXIBLE COUPLINGS"

Should be in your files—Send for free copy.

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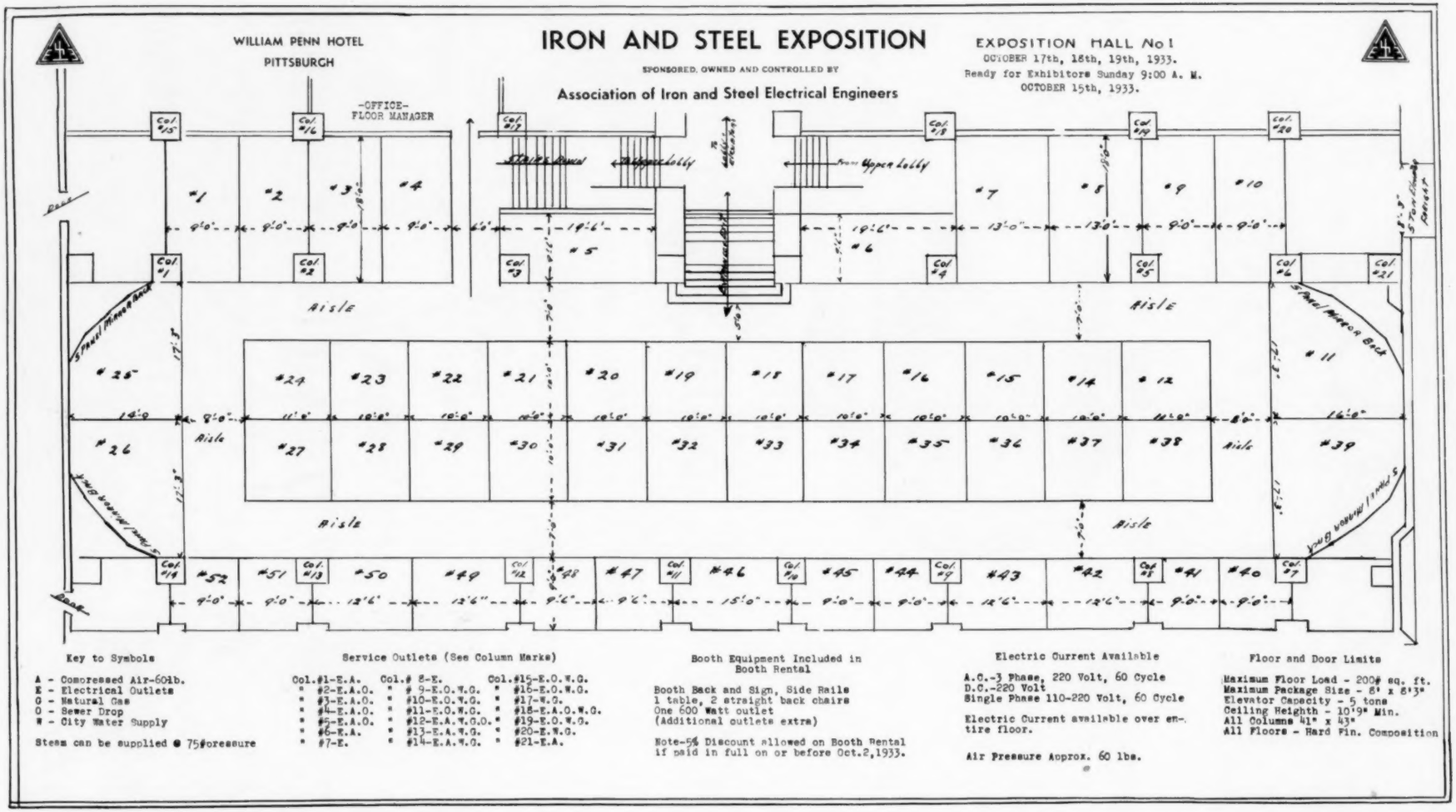
IRON AND STEEL EXPOSITION

PITTSBURGH, PA.–OCTOBER 17 - 18 - 19, 1933


WILLIAM PENN HOTEL
PITTSBURGH
IRON AND STEEL EXPOSITION
SPONSORED, OWNED AND CONTROLLED BY
Association of Iron and Steel Electrical Engineers
EXPOSITION HALL No 1
OCTOBER 17th, 18th, 19th, 1933.
Ready for Exhibitors Sunday 9:00 A. M.
OCTOBER 15th, 1933.
-OFFICE-
FLOOR MANAGER
Aisle
Key to Symbols
A - Compressed Air-60lb.
E - Electrical Outlets
G - Natural Gas
O - Sewer Drop
W - City Water Supply
Steam can be supplied @ 75# pressure
Service Outlets (See Column Marks)
Col.#1-E.A. Col.# 8-E. Col.#15-E.O.W.G.
#2-E.A.O. # 9-E.O.W.G. #16-E.O.W.G.
#3-E.A.O. #10-E.O.W.G. #17-W.O.
#4-E.A.O. #11-E.O.W.G. #18-E.A.O.W.G.
#5-E.A.O. #12-E.A.W.G.O. #19-E.O.W.G.
#6-E.A. #13-E.A.W.G. #20-E.W.G.
#7-E. #14-E.A.W.G. #21-E.A.
Booth Equipment Included in Booth Rental
Booth Back and Sign, Side Rails
1 table, 2 straight back chairs
One 600 Watt outlet
(Additional outlets extra)
Note-5% Discount allowed on Booth Rental if paid in full on or before Oct.2,1933.
Electric Current Available
A.C.-3 Phase, 220 Volt, 60 Cycle
D.C.-220 Volt
Single Phase 110-220 Volt, 60 Cycle
Electric Current available over entire floor.
Air Pressure Approx. 60 lbs.
Floor and Door Limits
Maximum Floor Load - 200# sq. ft.
Maximum Package Size - 8' x 8'3"
Elevator Capacity - 5 tons
Ceiling Heights - 10'9" Min.
All Columns 41" x 43"
All Floors - Hard Fin. Composition

Floor plan of the Iron and Steel Exposition held under the auspices of the Electrical, Mechanical, Combustion, Lubrication and Safety Engineering Divisions of the Association of Iron and Steel Electrical Engineers, Pittsburgh, Pa., October 17, 18, 19, 1933. An Exposition of the developments in apparatus and equipment to process and produce Iron and Steel.